

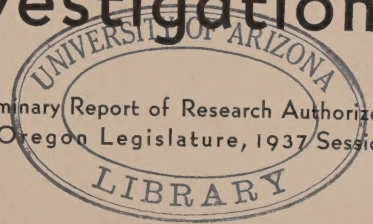
NURSERY INVESTIGATIONS

PEA PESTS & DISEASES

HOP PROBLEMS

Special Agricultural Investigations

A Preliminary Report of Research Authorized
by the Oregon Legislature, 1937 Session



ATO NEMATODE STUDIES

FERTILITY EXPERIMENTS

WEED CONTROL RESEARCH

GRAZING EXPERIMENTS

POULTRY RESEARCH

BUTTER QUALITY IMPROVEMENT

A BEETLE INVESTIGATIONS

LIVESTOCK DISEASES

FUR FARM PROBLEMS

FOREWORD

AT THE 1937 session of the Oregon legislature, a number of farmers' organizations of this state obtained special appropriations for carrying on investigations by the Oregon Agricultural Experiment Station and Extension Service in an attempt to solve pressing problems of the several enterprises and industries concerned.

In accepting the special tasks thus referred to it, which were to be carried on in addition to its regular research program, the Experiment Station made no advance promises as to immediate or final results. Scientific research work, it was pointed out, cannot be conducted with assurance of desired results in any given length of time.

Specific research projects were set up for each of the 20 special investigational tasks assigned to the agricultural division of the State College. These have been pursued diligently for the two years covered by the appropriations which end December 31, 1938. In every instance the work has been carried on with emphasis upon the problems deemed most vital by the industries concerned.

As was to have been expected, the results achieved to date have varied greatly in respect to practical solutions of the problems involved. In some cases, as is shown in later pages, new controls for pests and diseases have been found or new cultural methods developed which have meant the difference between continuing or abandoning otherwise profitable agricultural enterprises. In other instances partial solutions have been found, while in still others the results have been confined largely to the development of new and essential scientific data upon which further research can be based.

With two projects unforeseen circumstances made it impossible to make efficient and beneficial use of the entire appropriation within the time allotted and in such cases the unexpended portion of the funds provided are being returned to the state treasury.

Many inquiries are naturally received as to the progress that has been made with these special investigational projects. It seemed that the most practical and economical way to answer such inquiries and to make available information so far developed would be to combine condensed reports for all the projects in this single preliminary bulletin.

In the pages that follow attempt is made in each instance to state in brief the problem presented to the research men, list results achieved to date, refer to more detailed reports if such have been issued, and to summarize the additional work that appears necessary in case a continuation of the project is authorized.

WM. A. SCHOENFELD,
Dean and Director

Special

Agricultural Investigations

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Compiled by
Ralph S. Besse and John C. Burtner

Summary of Specific Achievements

Mention is made here of a few of the specific accomplishments resulting from the special research projects reported on more fully in the following pages. This is not intended to be in any sense a full summary of the work carried on.

The use of ethylene gas in nursery stock defoliation, and its danger in holly defoliation have been demonstrated.

Effective controls for Berckman's blight, cotton-easter web worm and juniper scale have been accomplished.

Soil surveys have been completed on 400,000 additional acres.

Control of alfalfa yellow top, beet canker and celery "scratch" by adding boron to the soil has been accomplished.

New poultry disease facilities aided materially in control of an outbreak of laryngotracheitis in Oregon flocks.

A control for turkey sinusitis was shown to be 94 per cent effective.

The vital relationship of cystine in proteins fed to lactating animals has been demonstrated.

Effective control of the filbert moth under ordinary conditions has been accomplished.

Control of the pea weevil under field or garden conditions has been made possible for the first time.

A control for aphids of trellis peas has been developed.

A 10-acre experimental hop yard was established and an experimental drier constructed.

Five new dried prune products have been developed and a successful control for prune thrips discovered.

Statistics on Oregon's specialty crops have been obtained for the first time.

Causative organisms of four livestock diseases have been isolated in Oregon for the first time, and control of one developed.

Importance of rotation in control of the flax worm was established.

Productivity of seeded grasses on logged-off lands has been demonstrated on a large scale.

Partial control of onion mildew and possible effective seed treatment for onion maggot discovered.

Basic information on improvement of butter texture in alfalfa regions developed.

Improved methods discovered for control of perennial weeds that cut the cost in half. Better chemical control accomplished on annual weeds, lawn weeds and poison oak.

Efficient service established through improvements in seed testing laboratory.

Importance of phosphate fertilizer in Malheur county demonstrated.

Strawberry clover demonstrated as practical on alkali soils.

Cultural and cropping practices developed for partial control of nematodes.

Experimental fur farm established and progress made with food formulas and breeding management.

Oregon State System of Higher Education
Agricultural Experiment Station—Federal Cooperative Extension Service
Oregon State College, Corvallis

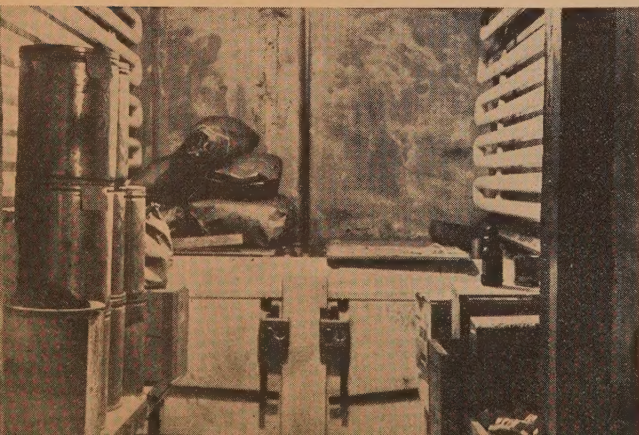
Research Yields Results For Nursery Industry

The commercial production of nursery stock is a major industry in Oregon and one which fits in admirably with the need of this state for specialty crops of comparatively high value which can be shipped long distances. Income from plant materials including bulbs and ornamental flowers now exceeds \$3,000,000 annually, approximately 85 per cent of which is from sales made to points outside the state boundaries. More than 1,000 individuals are engaged in the production and marketing of nursery stocks at present and there is reason to believe that the industry will undergo material expansion if certain cultural and pest problems are solved.

The problems of disease and pest control are no more serious in Oregon than in other parts of the country but in many respects they are different. Some of the climatic and soil conditions which particularly favor Oregon as a source of nursery stock also are favorable to the development of certain types of diseases and pests.

Until the start of this project the work that had been done on cultural, disease and pest problems of nursery stock was extremely limited in scope. So many problems have developed through the years that it was necessary to make a selection of the most important ones and direct the present investigations largely toward the study of these. In making such selection the advice of the organized commercial nurserymen was followed. The investigation was divided into three main phases—horticultural problems, nursery diseases, and insect pest control.

Experimental cold storage room constructed at the Station. A common storage cellar was also provided.



A successful defoliation method was developed. A, untreated rose plant; B, defoliated with ethylene gas.

Horticultural Investigations

Many problems of a purely horticultural nature have developed within the nursery industry having to do with such nursery practices as growing, digging, packing, storage, transportation, and propagation of nursery stock.

Results Obtained

Facilities Developed. An early step necessary in carrying out these studies was the development of special facilities for research on horticultural problems of the nursery industry. A small but thoroughly modern and efficient experimental storage plant has been installed which permits a wide range of controlled temperatures and humidities. The cost of this plant was kept at an unusually low figure by the fact that staff members developed the plant themselves to a considerable degree. A common storage cellar was also provided to supplement the work of the main storage plant. A complete irrigation system was installed on the five-acre tract made available for field experiments. A large collection of nursery stock has been set out for use in experimental work. Additional laboratory facilities have been provided for the fundamental research involving chemistry and plant physiology.

Storage of Rose Plants. Storage studies to date indicate that a constant temperature of at least 31° F. is necessary to keep Oregon-grown rose plants in a dormant condition. Even two degrees higher temperature resulted in breaking buds while six degrees higher resulted in substantial new growth. Plants held in commercial storage showed new growth of from three to eight inches. The humidity studies showed no visible difference when percentage of moisture ranged from 30 to 50 per cent.

While these experiments produced encouraging results from the standpoint of controlling dormancy and retarding the growth of mold, they were disappointing in relation to later field growth. Plants from the various cold storage lots did not make satisfactory growth in the field and mortality was high. No adequate explanation for this condition has yet been found. Cold storage of Oregon-grown rose plants appears to be a questionable procedure until the cause of the trouble has been ascertained.

Rose Defoliation. An effective and harmless method of defoliating roses and other plants at the time of digging has been developed as a result of these studies. Such a method has been stressed as a pressing need by nurserymen. The defoliation has been brought about by subjecting the plants to very minute quantities of ethylene gas. The gas used may be either artificially prepared ethylene or that which is given off by such fruits as apples and pears during the ripening period. Defoliation by this method is followed by normal maturity, so that no detrimental effects have been noted.

Premature Defoliation of Holly. The same ethylene gas which has been put to beneficial use for defoliating nursery stock was found to be responsible for the premature defoliation of holly which has caused serious financial losses to the trade and to consumers. Experiments have shown that the holly plant is extremely sensitive to ethylene gas even in amounts as low as one part in 20,000,000. Fruit kept in close proximity to holly will give off enough of the gas to cause the damage, or it may come from illuminating gas or other combustible materials. The industry has been warned of the danger of storing or shipping holly with fruit, and the danger of keeping it in establishments where gas is used for heating or other purposes.

Cold storage of peony flowers was successful (left), but attempts at forcing gave imperfect flowers (right).



Comparison of growth of pyramidal arborvitae cuttings. A, untreated; B, treated with a growth promoting chemical.

Growth Hormones. Notable results have been obtained in experiments with hormones and growth promoting substances. There is ground for belief that these materials will ultimately be valuable aids in the propagation of certain species by cuttings. They may stimulate root development with certain difficult species, may improve the type of root system with others, and may reduce the time necessary to induce rooting. It has been found, however, that these are not a cure-all for ills of propagation and the treatment must be varied according to the type of plant.

Preservation and Forcing Peonies. Experiments conducted at the request of the industry on preservation and forcing of peonies have shown that the blooms respond well to refrigeration which makes it possible to hold them from three to five weeks where field development is in advance of the best marketing periods. All attempts to force peonies where the situation is reversed have resulted in failure to date.

Conclusions

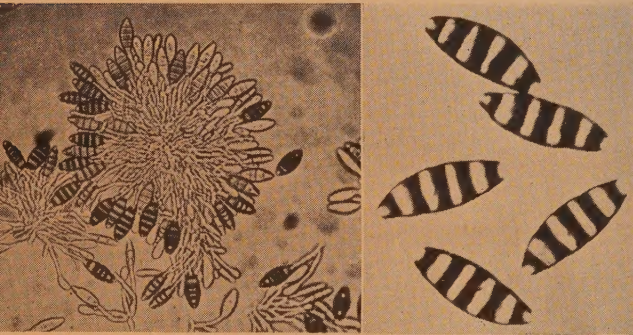
Much of practical value to the nursery industry has already been discovered in connection with the horticultural phase, particularly in the field of defoliation studies. Findings have been reported to the industry and are already being put to use. Storage studies have brought considerable new information although they must be carried on longer before solutions of present problems can be expected. The study of hormones and growth promoting substances has shown the high potential value of some of these but has also revealed the danger of their indiscriminate use before further data is developed.

Nursery Diseases

The susceptibility of nursery stocks to disease is not surprising in view of the fact that more than 1,000 different kinds of plants are classified as nursery stock. In the course of this study requests have been received for the investigation of more than 70 different diseases involving more than 30 kinds of nursery stock. Instead of spreading the work over such a wide variety of difficulties, a more intensive study has been made of the most outstanding problems. Advice has been given to the extent possible to growers encountering difficulties not included in the investigation.

Results Obtained

Nursery Established. A disease plant nursery has been established where the cause of each disease and the reaction of plants to control measures could be closely followed. In connection with this special inoculation chambers were constructed in which to study the various organisms.



Coryneum, the primary organism in Berckman's arbor-vitae disease, shown here in the spore stage. (X 200 and X 500)

Berckman's Blight. The cause of the serious blight of Berckman's and related oriental arbor-vitae was found to be a species of *Coryneum* fungus closely related to the one which has attacked the Monterey cypress in California. It became so serious that nurserymen have had to destroy large quantities of shrubs in their nurseries which had changed color from the desired golden yellows and bright greens to an ugly brown. Bordeaux sprays and sprays of the copper oxide and basic copper sulphate type were found to control the disease without injury to the plant when applied at the proper time. Many important spray tests are still



Part of the experimental nursery plantings used in disease and pest control studies.

in progress to determine the proper time of application and the number of sprays required.

On the basis of the first season's results Station Circular of Information No. 186 has been issued and is now being used by growers.

Black Mold of Roses. Damage to shipments of Oregon rose stock to the east had been blamed on disease conditions. The situation was threatening the entire Oregon rose trade. Investigations showed that the trouble was caused by a black mold which had contaminated the plants after they were dug. The organism was traced to certain packing sheds and steps to prevent reoccurrences have been taken.

Storage Dieback of Roses. It has been the belief among rose growers that the common mildew of roses is responsible for a dieback condition which attacked the soft immature wood of rose plants placed in storage. Investigation has shown, however, that the injury is not caused by rose powdery mildew at all but by a *Botrytis* fungus which is a common mold on living and dead tissues of many plants. A number of experiments with sprays and dips and handling practices are now in progress.

Gladiolus Dormancy. A study made of a form of gladiolus dormancy showed that the difficulty was unrelated to any disease-causing organism. Methods of irrigation and culture which should circumvent a recurrence have been suggested.

Conclusions

A valuable start has been made in meeting many of the nursery disease problems both as regards the development of specific controls and the clearing up of mysterious conditions which had been erroneously attributed to disease conditions. Progress has been made with numerous diseases not mentioned here specifically. A continuation of the research now underway could be expected to result in even more important practical results for the nursery industry.

Nursery Insects

The wide diversity of plant materials with which the nursery industry is concerned leads to much the same situation as regards insect pests as was described under diseases. During the course of these studies more than 100 insects have been found damaging nursery stock. Because of the time available only the currently more important insect pests have been studied.

Results Obtained

Scope of Experimental Work. A planting has been established near Corvallis consisting mostly of conifers that have been used for tests on the tolerance of tree varieties to insecticidal sprays. Tests have been made on many of the pests in the laboratory using small potted plants. Experimental tests have also been conducted in cooperation with growers.

Holly Bud Moth. The seasonal life history of this pest has been determined after which sprays for its control were tested. One light summer oil spray similar to that used for control of the blackberry mite shows considerable promise since it destroys the eggs of the moth before damage is done. Sprays have not been sufficiently tested under varying conditions.

Poplar and Willow Borer. This relatively new pest of willow and poplar has also attacked beech trees in nurseries. The grubs girdle the trunk killing the tree or destroying its market value. Applications of several different kinds of poison dust to control the adults before the eggs are laid have given promising leads.

Cotoneaster Web Worm. The cotoneaster web worm is a newly discovered insect, the damage of which was first brought to attention in 1929. It



Cotoneaster webworm injury. This new pest can be completely controlled as a result of these insect studies.

was not previously found in any insect literature. Its attacks are confined principally to the horizontal type of cotoneaster although it attacks other species to a certain extent. Control tests revealed that the use of a pyrethrum oil spray similar to the common household fly spray will give adequate control of this pest. The life history studies have been completed, and, with the development of a satisfactory control method, this phase of the project is considered completed and the publication of a circular is contemplated.

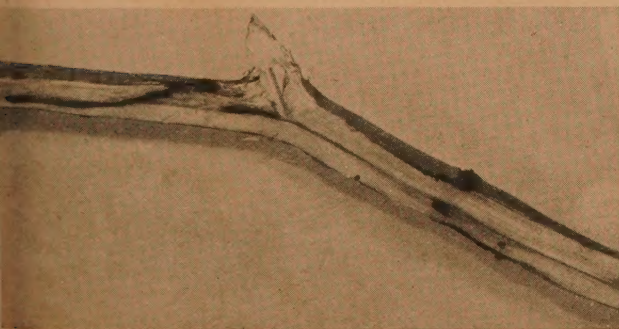
Twelve-Spotted Cucumber Beetle. This is a general feeder causing damage to nursery crops as well to many other plants. Under laboratory conditions both pyrethrum dust and pyrethrum spray, which are commercially available, have shown the best control.

Omnivorous Leaf Tier. This is one of the most serious insect pests in Oregon and is mentioned elsewhere in this report in connection with flax and hops. It also attacks certain kinds of nursery stock among its 95 known species of host plants. Extensive studies of its life history have been made in cooperation with other related projects. With the exception of the development of certain cultural practices no satisfactory method of control has been found.

Conclusions

Satisfactory control of several of the worst insects attacking nursery stock has been developed as the result of these studies, although, with the exception of a single case of the cotoneaster web worm, the investigations have not been carried to the point of completion. The additional work needed involves further life history studies in some cases, and in others the further testing of control materials either in the laboratory or under field conditions or both. Progress has been made with the study of a score of insects not mentioned specifically here.

Tunnels caused by poplar and willow borer (above) and girdling of birch trunk caused by this insect.



Work Continued on Fundamental Soil Studies

The Problem

Soil is Oregon's greatest natural resource. If it is to continue to support life it must be conserved and properly utilized. The production of crops requires definite amounts of plant food. If these are absent or too limited successful production cannot be realized.

An invoice of the land resources and the fertility needs provides a guide for improvement of crop production and maintenance of productive capacity. Such an invoice would give the information required in developing a permanent system of agriculture on each type of Oregon soil and on every farm.

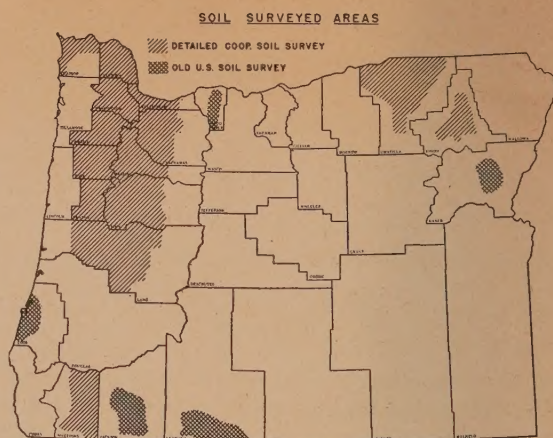
Many farmers struggling with irrigation and soil moisture problems are seeking information on economic methods of utilizing available water to obtain maximum yields at less cost.

Funds for this project were appropriated by the 1937 Legislature to extend the investigations of soil and irrigation problems which have been conducted by the experiment Station for many years. Phases of the work given special attention during the past two years include soil surveys, irrigation, fertility, ground water, and alkali land reclamation.

Results Obtained

Soil Surveys. In cooperation with the U. S. Bureau of Chemistry and Soils the soil survey program was carried on in Umatilla, Clatsop and Baker counties. The Umatilla survey, which has been underway for several years, was completed. In Clatsop county 150,000 acres of agricultural land were surveyed and in Baker county 250,000 acres were mapped.

The soil survey consists of a careful inspection and study of the soils in a particular area to de-



termine the type, quality, depth and extent of the respective soils and the crops they are adapted to produce. The results of a survey serve as a guide in planning and adjusting the crop program and in developing a permanent system of agriculture. Intelligent use of soil surveys prevents unwise plantings and unsound land investments. Each soil type, like a plant species, has its use and limitations. It can be defined and classified in a permanent manner after its capabilities and limitations are determined.

During the past 20 years approximately 7,500,000 acres of the agricultural lands in 14 counties have been surveyed. General surveys have been made of practically all reclamation projects, and general agricultural and economic feasibility surveys have also been conducted.

Fertilizer Requirements Studied. Fifty-six fertilizer trials were conducted on 1,200 different plots of ground throughout the state during the past two years. These experiments sought information on the major nutrient elements needed for plant production and the role of fertilizers in a sound production program.

In those tests it was found that potassium gave a three-fold increase in yield of beets on the soils of Lake Labish. Phosphated manure more than doubled the yield of red clover hay. Superphosphate increased the yield, protein and sulphur content of ladino clover pastures. Boron at the rate of 30 pounds per acre controlled "yellow top" on western Oregon alfalfa, greatly increasing

Fertility studies with alfalfa and other plants showed that iodine is one of the essential minor elements.



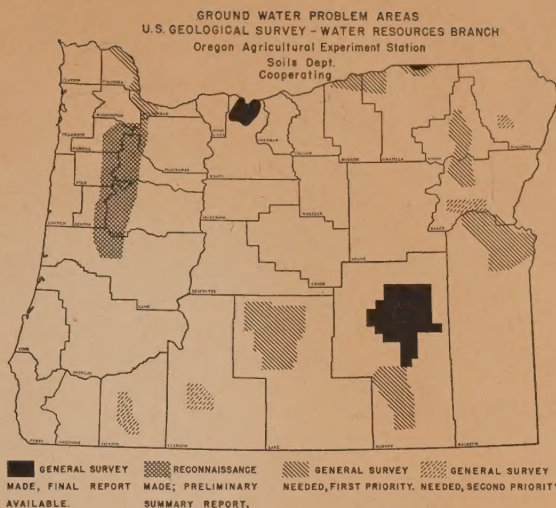
ields. Boron was also effective in controlling beet canker and celery "scratch".

Irrigation Problems Investigated. In the Willamette Valley the irrigated area has increased from 3,000 acres to 25,000 acres during the past ten years. This rapid expansion has created many problems requiring experiments to determine economic installation of irrigation systems and effective methods of water application. Tests of irrigation practices were made in 24 fields in the Willamette Valley and coastal areas. Several pumping units were inspected and checked for efficiency. Soils which had been irrigated with given amounts of water were tested for available phosphate, wilt-point, and useful water capacity.

Ground Water Problems. To determine the amount and location of ground water supplies which may be available for irrigation, municipal or industrial use, the Experiment Station in cooperation with the U. S. Geological Survey has conducted ground water surveys in the Harney Basin, The Dalles district, the Willamette Valley and a reconnaissance survey in the vicinity of Clatskanie. A report of these surveys is included in Experiment Station Circular 124, published in 1937.

Alkali Reclamation. It is estimated that large acreages of Oregon's alkali lands which are now liabilities may be reclaimed and put to productive use. For 16 years experiments have been underway on a 14-acre tract at Vale in Malheur county, where from 25 to 80 per cent of the alkali salts have been eliminated with various treatments. Sulphur has been the most effective single treatment for neutralizing alkali so that leaching could proceed where deep drainage and copious irrigation were provided. Alfalfa has been successfully produced on this black alkali land in 10 plots which have received various sulphur or sulphate treat-

Boric acid applied on alfalfa "yellow top" in July, 1937, gave 350 per cent increase in 1938 third cutting. Comparison is shown below.



ments. Strawberry clover has given promise as an alkali resistant and salt tolerant plant.

Conclusions

Steady progress has been made under this project in continuing the important soil investigations which have been the basis of Oregon's agricultural advancement in the past. Maintenance of fertile soil is the first essential in insuring production and income for the future, as cropping practices evolve from the pioneer stages into permanent systems of agriculture.

Preliminary findings indicate that boron may may do as much for alfalfa in western Oregon as sulphur has east of the Cascades. It may also eliminate most of the canker losses on cannery beets.

Although a large part of the agricultural lands are now included in soil surveys, there still remain counties with important areas not yet reached. With an ever expanding program of irrigation, increased demands are received for investigation of more efficient methods of applying water.

Spray irrigation of onions on Labish peat soil. Close to 25,000 acres of western Oregon land are now irrigated.



Research Reveals Four Range Disease Causes

The Problem

The range sheep and cattle industry of Oregon constitutes one of the most important branches of the state's agriculture, utilizing approximately three-fourths of the area of the state—land unsuited to other types of agriculture. There are about 2,500,000 sheep in Oregon, four-fifths of which are east of the Cascades. Beef cattle numbers total between 450,000 to 500,000, all but about 25,000 being grown on eastern Oregon ranges.

Losses from disease have become increasingly serious to the range livestock industry. Sterility or shy breeding causes the heaviest losses to cattlemen, affecting some 20 per cent of the cows and entailing an estimated annual loss of \$1,360,000. Scours in calves also proves serious periodically.

Sheep diseases considered most serious when this investigation was started were lungers disease, stiff lambs, lamb dysentery and pregnancy disease. Since then a "sudden death" disease in Curry county and Black disease have been added. Estimated annual losses from these diseases of sheep total close to \$800,000.

Results Obtained

Objectives of the investigations have been to develop methods of control, treatment, and eradication where possible. First requirement in any disease study is systematic investigation of the causes, methods of transmission and other characteristics of the disease.

Investigations for the past two years have been largely confined to sheep diseases as these were considered by range operators to be of an emergency nature compared with the sterility problem in cattle raising. Furthermore, the latter problem

Typical symptoms of one of six types of stiff lamb diseases which cause heavy losses in Oregon.



A, knee joints affected by stiff lamb disease; B, organism which causes the trouble (X 2000).

is closely allied to the sterility studies already in progress with dairy cattle.

Stiff Lambs. At least six different types of so-called stiff lambs have been found. Causes of two of these have been established, while one was already known. One organism, *Erysipelothrix rhusiopathiae*, isolated for the first time in Oregon, produces lame lambs and diseases in chickens, swine and humans. A moving picture was taken showing the different types of stiff lambs and is being used as an aid in recognizing and preventing the disease.

Sudden Death in Curry County Lambs. Bacteriological studies of lambs dying suddenly in Curry county revealed an organism similar to if not identical with that responsible for so-called pulpy kidney disease of lambs in British possessions and the so-called milk colic of lambs in Texas. Final identification of the organism is now being sought through British workers. Antitoxin was obtained from England and Texas and injected in the lambs on the farms where losses occurred. Where this treatment was used, losses were only one-seventh as great as on farms where the antitoxin was not used.

Where animals died on fluke infested pastures, it was found that a club-shaped anaerobic bacterium was present which proved very pathogenic for sheep and which produced a very potent toxin. This organism is similar to, if not identical with the anaerobe which causes the so-called black disease in the British Empire. When injected into sheep, the organism causes death in about 24 hours. Sheep can be protected against this organism with an antitoxin or toxoid obtained from England.

Lunger Disease. Progressive pneumonia, or lungers disease, as it is called in eastern Oregon, has frequently been blamed on dust inhaled on long drives. Efforts were made to reproduce the disease with dust obtained from eastern Oregon driveways. The results of these dustings have not been conclusive but they are encouraging. No causative organism has been found, which confirms

the findings of other research workers with this malady.

An important discovery was made through bacteriological examination of naturally occurring cases. Such studies showed that the lung disease is frequently associated with an infectious disease known as caseous lymphadenitis or pseudo tuberculosis. A specific organism causing this disease was isolated and typical lesions were produced in guinea pigs. About 33 per cent of so-called lung disease cases autopsied proved to be infected with this related disease. It is hoped that a favorable method of testing suspected animals can be developed.

Pregnancy Disease. This disease has been common in both eastern and western Oregon, causing the death of pregnant ewes carrying twins and triplets. It normally occurs about two weeks before lambing time. Attempts at reproduction produced typical symptoms in ewes. In some groups of ewes the disease was produced by feeding grain hay, resulting in a high mortality.



Lung disease of sheep is one of the serious problems. A, normal lung; B, diseased lung; C, organism of closely associated disease (X 2000); D, ulcers caused by organism.

In all cases ketone bodies were present in the urine before other symptoms occurred which gives a rather simple method of diagnosis. Various recommended remedies were tried during the experiment although only one ewe so treated recovered. It had been given molasses. It is possible that if molasses is used early enough it might prove fairly successful as a treatment. Prevention of this disease is more promising, however, especially in animals where early diagnosis is possible.

Miscellaneous Studies. Some work has been done with the study of growth troubles of lambs and ewes on irrigated pastures, believed traceable to parasitic infestation. A preliminary investiga-



Sheep dead in 24 hours from Black disease. Insert shows causative organism (X 2000).

tion was also made of dysentery among calves in one eastern Oregon herd. As the trouble disappeared before the study could be completed, no satisfactory explanation was obtained.

Conclusions

During the two years that diseases of range sheep have been studied under this project, at least four different causative agents have been isolated for the first time. When it is realized that disease problems are not solved simply by finding causative agents, this is an essential first step which is frequently difficult to attain.

With four definite causative agents now known, rapid progress should be made in finding satisfactory remedies or methods of prevention. Some progress has already been made in this direction, particularly in connection with the sudden death losses in Curry county lambs and with the pregnancy disease. While it is considered that very good progress has been made, it is apparent to the workers that much remains to be done before losses from these diseases can be reduced to a minimum.

Curry County "sudden death" disease. A, causative organism (X 2000); B, injecting antitoxin to protect sheep.



Rotation Only Solution Found for Flax Pest

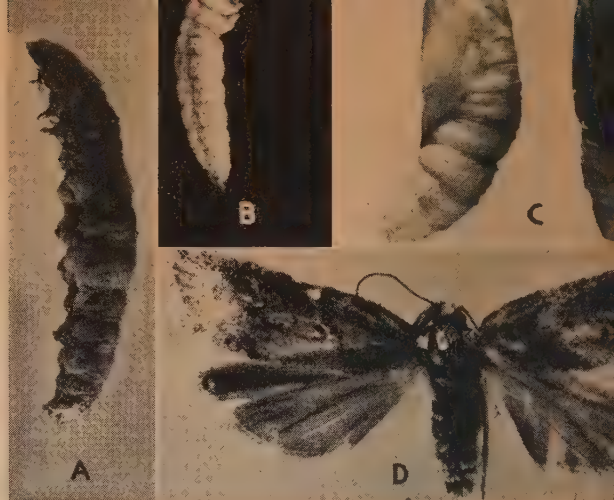
The Problem

Western Oregon produces from 80 to 90 per cent of the total fiber flax grown in the United States. Cultural practices have been developed so that good yields of long fiber flax can be obtained and processing methods have been improved. Favorable soil and climatic conditions prevail in the Willamette Valley, where more than 700,000 acres of land suitable for fiber flax production are available if conditions ever warrant production to that extent.

Unless practical measures can be worked out to control insect pests which threaten this crop, however, present production will not only be eliminated but future expansion will be abandoned.

Of these pests the flax worm, *Cnephasia longana* Haworth, is the most serious. It feeds on the tender growing tips of the flax plant causing the growth to stop at that point, and to "stool" or send out lateral shoots below the point of injury. During the scutching process the fiber breaks at the place where the injury occurred, thereby lowering the quality. The flower of the plant is also attacked and in cases of severe infestation the yield of seed is seriously reduced. In some of the fields examined more than 70 per cent of the plants were damaged.

The flax worm is known to feed on 95 different species of plants including cereals, vegetables, fruits, legumes, and nut and ornamental trees. Fifty-eight new host plants were found in Oregon during the past two years. First discovered near Portland in 1929, the flax worm has since been



Stages in life of flax worm. A, larva which does the damage (X 3); B, larva just before pupating (X 2); C, pupae (X 3); D, adult moth (X 3).

found throughout the Willamette Valley as far south as Creswell, Lane county, and as far north as Puyallup, Washington. So far as available records show, this is the only part of North America in which this insect occurs.

Other potential insect pests of flax are the western twelve-spotted cucumber beetle, the spittle bug, and the alfalfa semi-looper. Although these insects are known to damage severely other crops, injury to flax has been of minor importance.

Results Obtained

Rotation Control. From observations made on 76 fields it appears that crop rotation in which flax

Damage done by flax worm. At left, normal flax stalks; right, branching caused by work of flax worm.



Oregon land and climate are well suited for production of high quality fiber flax.



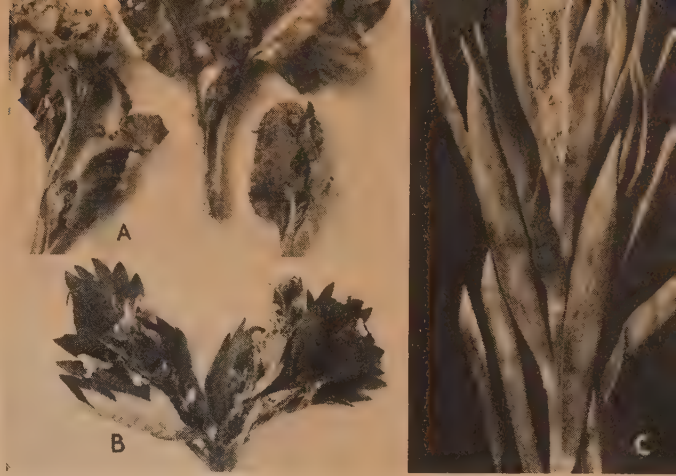
follows a cultivated crop offers the best possibility of controlling the flax worm thus far found. Samples from 38 fields of flax preceded by a leguminous crop showed an average injury of 10.55 per cent whereas samples from 21 fields of flax preceded by a cultivated crop showed only 3.11 per cent injury. Controlled experiments intended to prove the effectiveness of the rotations observed were started in 1938. Such tests, however, require several years for completion, hence final results are not yet available.



Harvest scene in an Oregon flax field. Growers are using efficient methods of production.

Chemical Baits and Dusts. To determine the extent to which the adult moth population might be destroyed by the use of poisoned baits 27 different chemicals were tested. The results indicated that none of the materials were effective as a supplementary means of control. In dusting trials where several insecticides were tested, lead arsenate-lime, (20-80), showed some promise.

Parasites. It was discovered that a considerable number of the larvae were killed by an unidentified fungus disease in 1937. In 1938 six species of parasites were reared in the laboratory from larvae collected in the field. One of these species had parasitized over 15-per cent of the larvae in the Canby area. Observations to determine the spread of these parasites and the relation they may have to flax worm control are being continued.



The flax worm, also called omniverous leaf tier, feeds on at least 95 different plants. A, damage to sugar beet; B, feeding on strawberry leaves; C, pupating in flax tip.

Conclusions

Facts which may lead to control of the flax worm through crop rotation have been discovered as a result of the research carried on under this project. Fortunately the same rotations that appear to give the best control of this pest are those which have been advocated as best from a cultural standpoint in flax production. More controlled experiments with rotations as well as more study of possible dissemination of the insect by wind in certain stages of its life history are needed before control by this method is assured. In the meantime such rotations are recommended as the best control now known.

More experiments with dusting, spraying, baiting and other toxicological tests both under laboratory and field conditions are needed as a means of finding other or more certain methods of control. The research work on this project, while concerned primarily with flax crop protection, is valuable as a protection to other farm crops which are being threatened by this serious pest.

Flax sheaves drying after retting at an Oregon processing plant.



Good Grass Produced on Logged-off Test Area

The Problem

In recent years public attention has been focused on the rapidly decreasing stands of timber and the large areas of cut-over land which generally produce no income. Logging operations have left western Oregon with approximately 3,000,000 acres of logged-off land. It appears that most of the virgin timber will be gone from some of the counties within a few years. The usual practice after logging is to burn the slashings which destroys the brush and debris but leaves most logs and stumps. If the slashing fire is a hot one most of the trees left standing are killed. Fireweed and other weeds and brush soon cover the ground and, if not grazed, soon become a fire hazard. In many cases a second and third burn has run over the land almost denuding it of forest trees capable of reseedling.

In many instances owners of such lands have ceased paying the taxes and permitted them to revert to the county. For example, in Clatsop county in 1937 some 30,000 acres were deeded to the county by owners without waiting for tax foreclosure. In the same county the assessed valuation of timber has been reduced from \$18,000,000 in 1918 to approximately \$4,000,000 in 1938.

It is believed that a considerable amount of the cut-over lands can be converted into productive agricultural use in the interim between logging

and timber regrowth. The production of forage crops for livestock grazing appears to offer the best means of obtaining an immediate return from these lands as well as those suited to permanent grazing.

Results Obtained

Preliminary Work. In 1935, in cooperation with the U. S. Bureau of Plant Industry, the John Jacob Astor Branch Experiment Station seeded 20 plots



Cut-over land on experimental tract now covered with excellent stand of seeded grass.



This map shows the extent of logged-off or burnt-over timber land west of the summit of the Cascades.



Seeding grass by hand in the ashes following the slashing burn on the experimental tract, fall of 1936.

of cutover hill land, each with a different kind of grass, in an effort to ascertain the possibilities of controlling bracken fern and brush.

In February 1936 a committee of Clatsop county farmers at the County Agricultural Outlook Conference conducted by the Extension Service made the following recommendation:

"The seeding and grazing of logged off land is recommended. However, knowledge of the proper methods of seeding and of grazing management and of the effect of such management upon tree growth is not adequate. It is suggested that the Clatsop County Court set aside an area of county owned logged off land and obtain the services of the Oregon Agricultural Experiment Station to investigate and determine suitable pasture grasses and mixtures for logged off land and the best methods of handling such lands on a long-time or permanent basis."

Experimental Area Selected. Following these suggestions and others which were made, the Clatsop County Court, with representatives of the State Forester and the Experiment Station, selected a tract of 830 acres of typical cut-over land which the

The grass as it appeared in the summers of 1937 and 1938, affording abundant feed for sheep and cattle.



county leased to the Experiment Station for conducting the investigations recommended.

Sod-forming Grasses Seeded. Four grass mixtures were selected which past experience indicated would sod well and control fern, weeds, and brush. In October and November, 1936, these mixtures were seeded at the rate of 10 to 12 pounds per acre in different areas of 150 acres each. These and other mixtures were also planted on 16 one-acre plots which were fenced. The average cost of the seed was \$1.59 per acre and the average cost of seeding 40¢. The seed was purchased by the Clatsop County Court.

An excellent stand of grass was obtained. All of the grasses in the mixtures grew well except for legumes which winter killed. It is estimated that 75 per cent of the ground seeded was covered with grass in 1937. Most of the grasses produced seed and reseeded the ground. In 1938 the stand of grass was heavier than it was the previous year.

Fences and Corrals Installed. Following the appropriation by the 1937 legislature for "Investigations and research to determine methods of establishing pasture grasses in the burned and cutover areas in the coastal region of Oregon", a co-operative memorandum of understanding was entered into by the Experiment Station, the State Forester, and the Clatsop County Court.

The three agencies cooperated in building an excellent five mile boundary fence. This included the clearing of a right-of-way eight feet wide, four miles of cross fence, and fencing 16 "enclosures". Substantial corrals and scales for handling experimental livestock were installed. Three winter shelter sheds 20 x 40 feet were constructed from cedar posts and cedar shakes cut from the area.

Grazing Results. In June of 1937, 49 cows, 1 bull and 9 calves, purchased in Eastern Oregon, were put on the experimental area. As it was soon observed that this small herd was insufficient to handle the rapidly growing grass, 38 head of yearling heifers from the coast region were obtained. The eastern Oregon cattle were unaccustomed to the new conditions and did not settle down to eat the grass readily, in fact were not confined to the experimental area for several weeks because of a delay in completing boundary fences. Consequently they made an average gain of only 74 pounds compared with 148 pounds for native heifers.



Hundreds of visitors have viewed the experiment. Here a group is examining the corrals.

In April, 1938 a flock of 727 ewes with lambs, and 50 head of cows and calves were turned into the experimental area. The livestock grazed a total of 43,653 sheep days and 10,547 cow days. The lambs had made an average gain of 44 pounds when sold September 1 at an average weight of 68 pounds. The gain would have been much larger except that over half of the grass was destroyed by fire on July 16 and the sheep were herded outside of the experimental area for several weeks. Since the cattle are to be kept on the experimental area during the winter of 1938-39, average gains were not computed.

Fire Burned 300 Acres of Grass. On July 16, 1938 a fire which was started from falling embers from a forest fire north of the experimental area burned over 300 acres of the new grass before it was brought under control. Approximately 60 per cent of the feed supply available was destroyed. Despite this heavy loss of forage, sufficient feed was left to take care of all cattle. The burned-over area has been reseeded and a good stand of grass obtained.

Method of Controlling Elk Determined. Elk proved to be a factor during the winter months of 1937-38 when droves of from 35 to 40 broke through the fence and fed on the experimental grass. They destroyed two miles of fence which had to be replaced. Through the cooperation of the Department of Agricultural Engineering an extra barbed wire was electrically charged from batteries after being attached to stakes 30 inches outside the regular fence. It proved effective.

Many Visitors See Area. Evidence of the wide public interest in the grazing experiment is shown by the fact that 865 persons visited the experimental tract during the two years since the investigation started.

Soil Conservation Service Cooperates. In the summer of 1938 under a cooperative agreement between the Experiment Station, the Clatsop County Court, and the Soil Conservation Service the SCS furnished labor from one of its CCC camps for reseeding the burned area, for the construction of water holes, the development of springs and the installation of fence.

Conclusions

The experiments so far conducted have demonstrated that good sod-forming grasses can be established on logged-off land where a reasonably good burn of the slashings has been made.

Observations lead to the belief that the range type of old cows from the dry lands of Eastern Oregon do not become readily adjusted to the more humid climate of the coast area and are not desirable to place on this type of cut-over land.

It is believed desirable to put the livestock on the grass early enough in the spring to keep it closely grazed. The use of smaller fenced pastures so that some grass can be closely grazed to prevent fire hazard while other areas are allowed to go to seed, is a plan which should be given more consideration.

Seeding old burns in a practical and successful manner is one of the pressing problems in the development of grazing lands. The presence of ground moss prevents the seed from coming in contact with the soil.

Sheep herded in bands on unseeded areas tramp out the moss and make a better seed bed.



Onion Pests and Diseases Investigated in Oregon

The Problem

The commercial onion industry which had a cash farm value of more than \$500,000 in 1937 has suffered heavy losses from pests and diseases during recent years. The onion maggot is the most serious pest although cut worms and wire worms also do considerable damage. Mildew is the most devastating disease, destroying both seed and bulb crops.

Onion maggots spend the winter in the ground and emerge about onion planting time in the spring. When onions are small one maggot is capable of destroying many seedlings travelling from plant to plant down the row or even crossing from one row to another. Losses have ranged from 15 per cent to 75 per cent in some fields.

Results Obtained

Spraying Tests. Four applications of a spray mixture of Boredeaux and oil emulsion were made on seven plots in different commercial onion plantings. Field counts of the maggots were made, yields were measured and the cost of spraying was determined. While the results from the limited number of trials looked promising they were not definite enough to warrant recommendations.

Seed Treatment. During the 1938 season mercurous chloride (calomel) in powdered form was

Onion mildew caused the breaking down of seed stalks in this field, reducing yield and quality.



Seed treatment plots for maggot control. Left, check plot; right treated with calomel.

sown with the seed as a repellent. Production of onions from treated rows was 70 per cent greater than from those untreated. This powder is much lower in cost and easier to apply than either spraying or dusting and this method would be practical from the growers standpoint if in additional tests it is found to give satisfactory control.

Mildew Fungicides. Of the 25 different fungicides tested, copper oxide and malachite green used separately or in combination appear to have outstanding merit in the control of onion mildew. Neither fungicide burns the foliage when applied properly yet both stop the growth of mildew. Preliminary tests show the combination of these agents to be effective in stopping spore formation and reduce mildew infection.

Conclusions

The absence of mildew in 1938 prevented carrying to conclusion tests of materials which controlled mildew in preliminary trials. More extensive experiments will be needed before final recommendations for control can be made.

The calomel seed treatment for maggot control is the most promising lead discovered, but has not been tried yet on a commercial scale.

Maggot damage to young onion, and scattered stand caused by maggot injury in and Oregon field.



Tests Reveal New Crops for Malheur County

The Problem

Establishment of new irrigation facilities, which has practically doubled the farm land available for crop production of Malheur County, led to an insistent request on the part of farmers and others for experimental work to be carried on in the field of improved crop production. In the past the cropping system in Malheur County has centered largely around feed crops. With the inauguration of long-time management of public range lands, however, there is little likelihood of any increase in total livestock numbers within the county for many years. The need, therefore, is for an increase in cash crop production if disastrous surpluses of feed crops are to be avoided.

The research authorized by the Legislature has been carried out under two general headings. First, to find, if possible, new or improved varieties of crops which could be produced profitably in Malheur County, and second, to find out what fertilizers would be practical for use in reducing production costs and thereby increasing farm income. Active or advisory cooperation in carrying on the research was had from the Division of Forage Crops and Diseases of the U. S. Bureau of Plant Industry, the Cooperative Extension Service, the Bureau of Reclamation, and the agricultural committees of Malheur County granges.

Results Obtained

Research carried on in the past two years included the establishment and care of 44 crop nurseries where 87 varieties were grown and observed. The fertilizer trials included the establishment of 439 one-tenth acre plots of major crops.

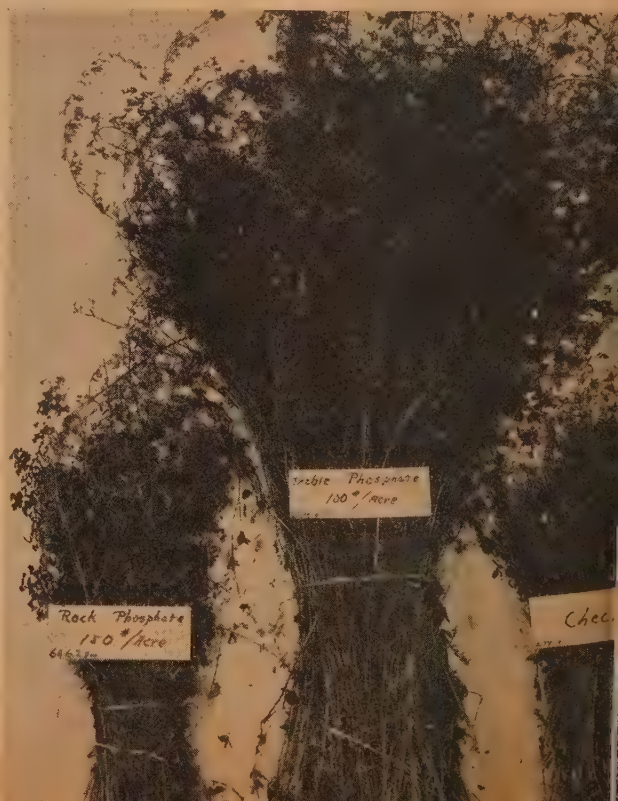
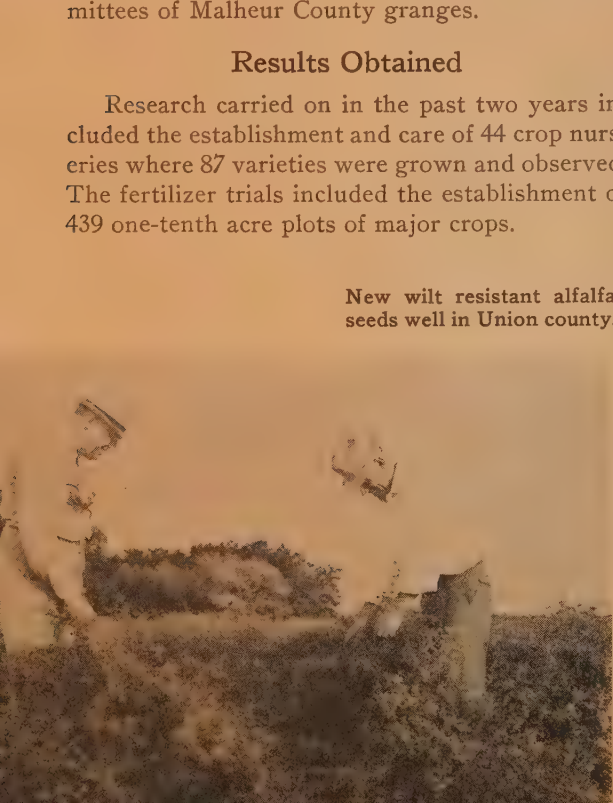
New wilt resistant alfalfa seeds well in Union county.

New or Improved Crops Introduced. In bringing new acres into production, there has been need of a crop which would grow well on the newly reclaimed sagebrush land and leave the soil in better condition for following cash crops. Soy beans appear to be such a crop. Tests carried on in the last two years show that the Virginia and Illini varieties will grow to heights of five feet or more on new land and hence offer excellent possibilities either as a green manure crop or as a forage crop. When turned under as green manure these soy beans, being legumes, add large quantities of both plant food and organic matter. If profitable markets for the seed are developed, the Cayuga and Minsoy varieties appear to be superior, with yields of 40 bushels per acre not uncommon. Other varieties also have been tested.

Seed flax was found to offer possibilities if handled so as to avoid loss from heat canker. Newland and Rio were the best in the two-year trials. Possibility of growing flax and wheat as companion crops to be separated after threshing have been partially studied.

While wheat is not expected to be a major crop

This comparison shows relative value of rock phosphate, treble phosphate and no fertilizer with alfalfa.





Fertilized onions at right compared with unfertilized.



Strawberry clover that yielded 15 bushels of seed per acre on alkali soil.

in Malheur county, a certain amount is needed in the cropping system for rotation or other purposes. Rust frequently causes heavy losses with the present favorite varieties, Federation and Dicklow. Out of 13 varieties tried this year, a new introduction, Minnesota 1085-4, proved to be the highest yielding and is apparently immune to rust. Further tests may prove it highly valuable either as it is or for breeding purposes.

Hybrid seed corn is proving to be one of the most promising cash crops for the area with large quantities already being shipped to the middle western corn belt. Some plot tests were carried out in 1937, although this year these were replaced by cooperative work with the commercial seed company now operating in this area.

Tests with barley favored Trebi, present popular variety, while potato trials indicate that White Rose may be more profitable than Bliss Triumph.

Strawberry clover, a new crop introduced by the Umatilla Branch Experiment Station, has produced in Malheur county at the rate of more than 15 bushels of seed per acre on limited plantings. It is the best crop yet found for use on soils too strong with alkali for normal crop production. Seed is so scarce at present that prices range from \$1.75 to \$3.50 per pound. It entails some harvesting problems because of its low growing character.

Continued tests have shown the superiority of the wilt resistant alfalfa developed by the County Agent in Malheur county and recently named Orestan. While it appears to be a shy seeder in Malheur county it has seeded well this season in the Grande Ronde Valley, hence an adequate seed supply seems to be assured. Grass nursery trials have shown some promise for seed production, although further tests are needed. Some additional information was obtained on field beans.

Fertilizers Tested. The outstanding development in the fertilizer trials is the almost universal

need of treble phosphate which will give profitable responses with practically any crop on which it is used in Malheur county. It hastened the maturity of potatoes by 10 days, gave better quality and increased yields. It was also the most valuable fertilizer for sugar beets, onions, alfalfa, and vegetable crops. Sulphur proved beneficial with potatoes, although it did not help much with alfalfa.

Treble phosphate gave an increase of 6.09 tons of sugar beets on one trial while potash gave a decrease in yield when applied alone. Results with onions, indicate that 8-12-8 fertilizer is highly satisfactory. Best yields with potatoes were obtained with 4-12-8 or 8-12-8 mixture. Use of treble phosphate on alfalfa increased yields from 18 to 190 percent and is definitely recommended. It also proved valuable in establishing new stands.

Conclusions

Many valuable facts in regard to new crops have been established in the two years, although in most cases definite conclusions cannot be drawn after so brief a test period. The fertilizer tests have shown conclusively that treble phosphate is the most valuable fertilizer although much remains to be determined regarding rate of application, combination with other fertilizer elements and extent of residual effects. Positive recommendations cannot be made in most instances although all facts so far developed have been recorded at the office of the County Agent and are being made available for the guidance of farmers in the region.

Seed flax and soy bean test plots. Both crops show promise.



Hop Pests, Culture, and Handling Investigated

Oregon is the nation's leading hop producing center. The 800 or more growers who produced over 17,000,000 pounds of hops valued in excess of \$3,500,000 in 1937 face problems of disease and pest control, drying, grading, fertilizing, cover cropping, irrigation, and other cultural items which influence income from the enterprise. Heavy financial losses have been sustained through lack of dependable information. But few of these problems have been investigated experimentally in the past.

Insect Pests of Hops

The Problem. Serious losses accrue from the effect of insects on hops. The red spider mite and hop aphid are the most widely distributed and destructive. The twelve-spotted leaf beetle, the hop flea beetle, the fall web worm, the hop butterfly, wire worms, leaf hoppers, the omnivorous leaf tier, cut worms, and thrips also damage hop fields.

Experimental Progress. Because an experimental hop yard where controlled experiments could be conducted was not available in 1937, the investigations centered around a study of the life history of the more important pests, a survey of the extent of damages, and preliminary toxicity tests.

Tests for controlling red spider were made with six dusts and seven sprays in 1938. None of the spray mixtures was effective in control and five of the dust applications gave unsatisfactory results. One dust, however, Dinitro-o-cyclohexyl phenol, gave 100 per cent kill with no injury to hop plants when used at a strength of .1 per cent to .6 per cent

Hops are one of the many hosts of the omnivorous leaf tier.



Hops are one of Oregon's important specialty crops.

with walnut shell flour as a carrier. The trials have been too limited to justify definite recommendations.

Hop aphid was not present in sufficient numbers during 1938 for field toxicity tests.

Several commercial hop yards which were irrigated by overhead sprinklers were inspected in 1938 and found relatively free from red spider. It is possible that irrigation of this type may have some effect on the control of this pest.

Conclusions. Although definite recommendations for the control of some of the major hop pests have not yet been worked out, considerable progress has been made in obtaining basic information preliminary to further experimentation under controlled conditions. The ground work for such investigations has been completed.

Hop Mildew

Control of downy mildew is probably the most important single problem facing the hop industry. This has been the subject of a cooperative Federal-Oregon Experiment Station project since 1931, the results of which have been made available to growers from time to time. While the special investigations authorized by the legislature have not dealt specifically with hop diseases, close coordination has been maintained between the regular and special investigational work.

Typical damage by hop red spider, a serious insect pest.



Agronomic and Cultural Methods

The Problem. Through the years hop growers have spent considerable money in an effort to determine the most economical and effective methods of producing quality hops. The grower's hope of reducing cost of production is in the use of cultural methods which will provide both increased yield and quality. Scientific experiments have been needed to determine which of the methods now in practice are best, and to work out new methods which will not only bring higher yield and quality improvement but will also assist in the control of mildew and other diseases and pests.



Hop dealers helped grade experimentally dried hops.

Experimental Progress. The first step in outlining production experiments with hops was to establish a yard where conditions could be controlled on the same land for several years so the cumulative effects of the treatments could be measured. Obviously commercial yards were not feasible for this purpose. A ten-acre experimental hop yard was established in 1937 on ground controlled by the Experiment Station.

Cover crop experiments involving 20 different crops including both annual and perennial plants were seeded in the fall of 1937 in the ten-acre experimental hop yard.

Experiments in training showed no significant difference in yield between two or four vines per hill. Those hills having five and six vines, however, produced smaller yields and poorer quality.

Plots suckered and stripped in the normal manner were compared with plots not suckered or stripped and with plots stripped to a height of seven feet. No significant differences in yield were obtained.

An irrigation of two inches increased the yield of early clusters 26 per cent, late clusters 11 per cent, and fuggles 3 per cent, or an average increase of 15 per cent over the non-irrigated plots.

Fertilizers applied at the rate of 300, 1000, and 2000 pounds per acre were tested. The season was too dry to show reliable results on the non-irrigated land and no conclusions could be drawn from the single year's tests.

Experiments in vine cutting, pruning, and crowning and the effect of different methods and treatments on yield, vigor, and length of life of plants were initiated. No results may be expected from these tests until 1939.

Conclusions. Investigations dealing with perennial crops such as hops require years of time for completion, hence one or two year's results constitute an unsound basis for drawing definite conclusions. The establishment of a ten-acre experimental hop yard and the starting of important projects on production practices pave the way for obtaining results from which recommendations can be made if funds are available for continuing the experiments.

Hop Grading

The Problem. Hops are marketed largely on the basis of physical characteristics without consideration being given to the chemical values which may affect quality. But little has been known concerning the relation of the physical and chemical factors. The prices growers receive for hops are usually a reflection of the variations in physical characteristics. However, the intrinsic value of the hops appears to be closely related to the chemical constituents.

The 10-acre experimental hop yard established in 1937.



Experimental Progress. More than 300 samples of hops showing an apparently wide variation in quality and appearance were stored in airtight cans for experimental use. These samples were subjected to two series of tests, one dealing with the physical factors which included a comparison of color, aroma, percentages of seed, leaves and stems, maturity, condition, and moisture content. The other dealt with chemical analyses to compare the relative contents of resins, oils and tannins. These chemical elements are exceedingly important in the brewing process.

A simple and accurate method for determining seed weight has been developed.

Careful comparisons were made to show the relationships between the amount of soft resins and the physical character of the hops examined. The experiments so far conducted show no such relationship. The soft resins being the most important constituents from the brewing standpoint, it appears that the determination of the value of hops by physical grading alone may not be representative of true value.

Conclusions

While it is premature to consider the development of grades and standards on the basis of these investigations some observations may be made.

(1) Certain physical characters are used so generally under present marketing conditions that they must be included under any set of standards which may eventually be developed. Many of these such as color, percentage of seeds and foreign material are susceptible of practical measurement.

New experimental dry kiln used in hop drying studies.



A gas furnace and fan system installed in new kiln.

(2) The apparent lack of relationship between physical and chemical characters emphasizes the necessity for the development of a simple, rapid, and reasonably accurate method of determining the amount of soft resins.

Hop Drying

The Problem. Hop drying is an operation which requires skill and care to prevent injury. High temperatures induce oxidation of the soft resins to hard resins. Care is necessary to prevent overdrying the cones which break easily when overheated, causing losses of the resin-bearing lupulin. If the hops are underdried heating and bacterial deterioration may take place after baling. To reduce losses experiments should be conducted to develop more favorable drying practices.

Results Obtained. A three story frame hop drier 28 x 42 feet and 25 feet high was constructed to provide space for experimental drying, for storage, and for baling. One kiln 9 x 10 feet was completed and equipped with a fan and gas furnace. A second kiln 5 x 10 feet was installed but not equipped. This drier is arranged to test small experimental samples as well as to dry hops in commercial quantities.

To obtain data on individual seedling hop plants, 400 different samples taken from the hop breeding trials, that include many foreign and domestic varieties, were dried. Most of these samples were then chemically analyzed to determine their resins, preservative value, and relative moisture content.

Conclusions. Experiments with the new hop drying equipment did not go far enough during the one season's operations to justify conclusions or definite recommendations.

Partial Solution Found For Filbert Pest Loss

The Problem

The most important insect pest of filbert nut production in Oregon is the filbert moth which was discovered in 1929 and has increased in numbers until it is now found in every filbert producing county in the state. The only known control has been the sorting out of wormy nuts which is a hand process, costing in some cases more than the value of the crop.

Since western Oregon's climatic and soil conditions are so favorable to filbert production, this section producing 83 per cent of the total United States crop, the control of this pest is most urgent not only from the standpoint of the income of individual growers but to retain for the state a most valuable specialty crop.

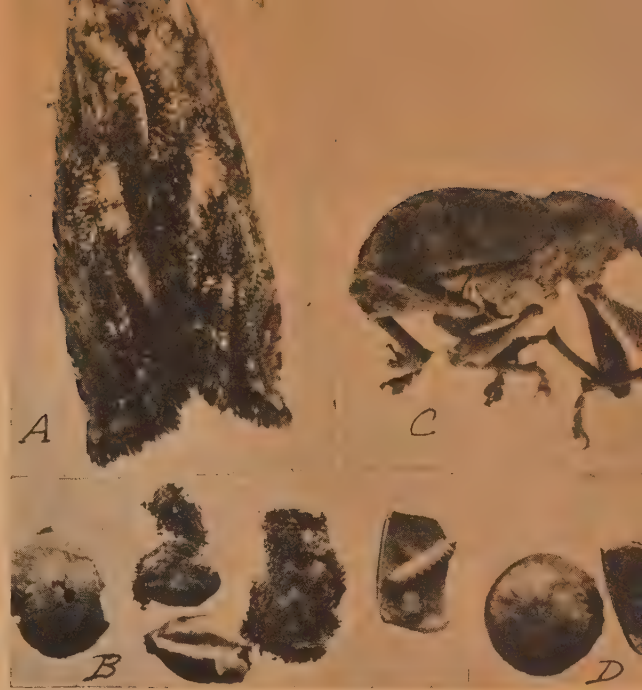
In addition to the filbert moth, other insects such as the gray leaf weevil, the fruit tree leaf roller, the polyphemus moth, and scale insects have been found to damage the crop by attacking buds, leaves and nuts.

Results Obtained

As a result of 20 different spray combinations which were tested, one has been found—lead arsenate three pounds to 100 gallons of water plus a spreader—which is effective in control. This spray reduced the number of wormy nuts to less than 1 per cent while 23.3 per cent of the nuts from unsprayed checks were wormy. Growers are now making use of this method of protection.

Dusting was ineffective in controlling worms although three dust combinations were tested.

Insect cage over tree used
in wormy filbert study.



A, filbert moth (X 8); B, larva of filbert moth and injury; C, filbert weevil (X 8); D, larva of filbert weevil.

A parasite that attacks the eggs of the filbert moth was discovered. Parasitized eggs were collected and the parasite reared and identified as *Trichogramma evanescens*. Further investigations will be required to determine the effectiveness of the parasite and the extent to which it controls the moth.

It was discovered that the small gray leaf weevil and the polyphemus moth can be controlled by a spray of three pounds of lead arsenate to 100 gallons of water.

Conclusions

An effective method of controlling the filbert moth under ordinary conditions has been developed and made available to growers. Since a few newly hatched larvae have been found at harvest time it is possible there may be a second brood, which would complicate control measures. In view of this a final spray program cannot be recommended until more information is available.

As the filbert moth is the same insect that causes wormy acorns, the influence of oak trees in the vicinity of filberts should be determined.

Further information on the seasonal life history is desirable in order properly to time spray applications.

The minor pests appear to be on the increase and methods of control should be developed.

Research in Problems of Fur Farming in Oregon

The Problem

In excess of 300 fur farmers in Oregon are faced with difficult problems concerning nutrition, breeding, disease and parasite control and other economic problems vital to the maintenance of an important industry which now produces about \$750,000 annually and for which Oregon is especially well adapted. Some fur growers have lost as much as 25 to 30 per cent of the new born whelps. There is a wide variation in fur development and fur quality. Serious losses have been reported from diseases and parasites. Fur farming is now definitely established as a farm livestock enterprise and is subject to the same general problems as other phases of the livestock industry.

Results Obtained

An experimental fur farm has been constructed consisting of 24 fox pens, three colony mink houses, 25 mink pens, a keepers house, a field laboratory and feed house. Through donations of fur farmers of the state and through purchases, 20 silver foxes, two red foxes, one gray fox, 21 mink, and six rabbits have been obtained. These animals together with the physical equipment indicated above form the basis for organized research projects which have been conducted.

Comparison of Elevated and Ground Pens. To answer the question of the effect on the parasite infestation and health of foxes tests have been made with elevated pens. These pens are 4x14 feet and have lower construction cost than those usually found on fur farms.



An elevated wire pen designed for sanitation and economy.

Foxes free from parasites placed in elevated wire pens have not been infested with parasites during one year's test. Neither did those infested with round and hook worms loose these parasites during the year's residence in these pens. Because of their portable nature the elevated pens lend themselves to better sanitary management for disease control.

No differences were noted in number of matings, number of young born, number of young killed by mother foxes in wire pens as compared with those kept in ground pens.

Foxes seem as contented on wire pens as on ground pens and take about the same amount of exercise in each. No important difference in fur priming was noted in animals housed in both types of pens.

Mink Pens. A variety of mink cages and houses are being investigated with the view to reducing cost of construction, allowing for better sanitation control, improved fur production, and maximum production of young. An effort is being made to determine the smallest size pen in which these animals can be successfully raised.

Nutritional Investigations. For the purpose of determining the effect of various food combina-

Rations for fur animals have been carefully worked out.



An experimental mink pen compared with standard size.





Ground pens for foxes arranged for one male to four females.



General view of experimental fur farm established in 1937.

tions on growth, reproductive cycle, health and development of the newborn, and fur production of both foxes and mink, nutritional trials have been conducted in which the food was weighed and the condition of the animals carefully recorded.

A cereal formula for both foxes and mink was developed.

Tests of fish meal as a substitute for fresh and frozen fish and meat indicated that fish meal can be used for three or four weeks at a time with mink but is inadvisable for a longer period as the health and fur condition of the animals are adversely affected. With foxes, however, the fish meal substitute looks more favorable, particularly with breeding animals. Thus far the tests have not been of sufficient duration to make definite recommendations. Skim milk and discarded candled chicken eggs were supplied as supplementary foods to foxes and mink without detrimental effects. Results thus far obtained indicate that eggs in particular may be valuable supplements during the breeding, gestation, and whelping periods.

Breeding and Reproduction Studies. Since one of the paramount problems in silver fox raising is that of breeding and care of the young, a number of investigations were organized to provide additional information. In these experiments the determination of the oestrus period of females was

made, the vitality of the male sperm was determined and artificial insemination was accomplished. Tests with drugs have been conducted to determine the effect on females who are prone to destroy their young shortly after birth.

Disease Problems. Many sick and dead animals brought to the Experiment Station by fur farmers were examined by the Veterinary Department and disease transmission trials have been conducted.

Genetic Studies of Fur. Preliminary work was started on studying the cell structure and composition of the fox and mink fur to determine the structure of hair as it may affect size, color, and sheen. This determination may show the relationship between structure and pigmentation and the degree to which these may be affected by heredity or nutrition.

Conclusions

Although definite conclusions cannot be drawn from the investigations thus far conducted, definite progress has been made during the past two years in starting experiments which are fundamental to the ultimate success of the fur farming enterprise. A survey of the problems, assembling the physical and technical equipment, and organizing essential projects of current interest to the growers paves the way for the more definite detailed research that may be required.

Mink houses with movable unit cages on both sides of building.



Even foxes get fleas and must be dusted regularly with insect powder.



Marked Success Attained In Pea Investigations

Pest Problems

Within the past five years the Pacific Northwest has become the most important region in the United States for the production of peas. The State of Oregon alone now produces in excess of 40,000 acres of peas for canning, freezing, seed, and fresh vegetable uses. This represents an estimated farm value amounting to \$1,425,000. The industry is particularly advantageous to Oregon because in certain regions east of the mountains, it affords the only major alternate crop for wheat. In western Oregon the crop fits in admirably with other vegetables and fruits in supporting a fast growing frozen food industry. On the Oregon coast peas constitute a profitable crop for supplying the fresh vegetable markets of the country.

The most serious insect pests of peas are the pea weevil, *Bruchus pisorum* Linne, and the common pea aphid. The pea weevil, nearly worldwide in its distribution, has long been regarded as a menace to pea production, particularly in seed growing areas. It had been the object of extensive research in Oregon as a pest of field pea seed production before the growing of green or process peas became a major enterprise. Weevilly peas are classed as unfit for human food under the federal regulations. Any infestation beyond an extremely low tolerance renders a crop unfit for processing.

When the pea industry in the Northwest expanded to large proportions, it was believed that infestations of pea weevil could be confined to trap crop strips on the outer edges of large fields and hence losses would not be serious. Experience proved to the contrary, however, and in 1936 serious losses were sustained, both east and west of



the Cascade Mountains, and by 1937 the infestation was so great as to threaten the entire industry unless it was speedily controlled.

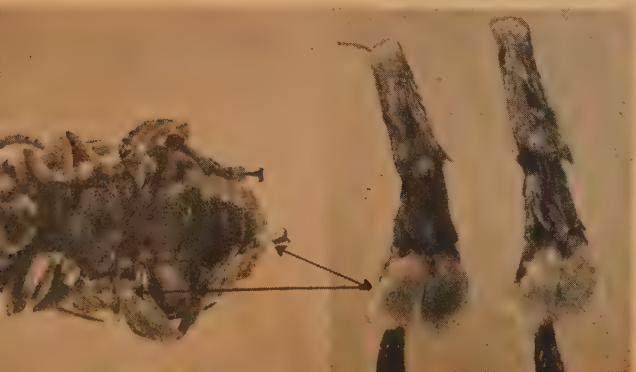
•The pea aphid was also rapidly becoming a major pest of the pea industry when preliminary investigations on control were started in 1935 and 1936 although the seriousness of the infestation varied greatly from season to season.

In 1934 half of the entire crop of cannery peas in Umatilla County was lost because of these insects, causing an estimated loss to growers of from \$100,000 to \$125,000. The Clatskanie area where several hundred acres of peas had been grown for the fresh vegetable markets was completely abandoned for pea production because of losses from pea aphid. In Clatsop County records kept at only one receiving station indicated a loss of from \$5,000 to \$6,000 to growers during 1935. Losses in Austrian winter field peas and vetch fields in the

The adult weevil on a pea blossom and on an immature pod.



Hair pads on the feet proved the key to pea weevil control.



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Willamette Valley have at times amounted to 50 per cent or more of the crop.

Results Obtained

Pea Weevil Control Accomplished. Preliminary laboratory work and plot trials carried on cooperatively by the Department of Entomology and the representative of the Federal Bureau of Entomology and Plant Quarantine stationed at Corvallis had shown prior to 1937 that the pea weevil was especially susceptible to rotenone-containing compounds. Rotenone is a poison obtained from the roots of certain tropical plants which is toxic only to insects or cold blooded animals.

Under the enlarged scope of investigations authorized by the Legislature, the facts discovered in the laboratory and with plots were applied in 1937 under field conditions in the early pea producing areas in western Oregon. Rotenone dusts of varying strengths were applied by all sorts of apparatus. It was found that whenever dust of three quarters of one per cent rotenone was applied while the adult weevils were depositing eggs, the kill was almost 100 per cent complete.

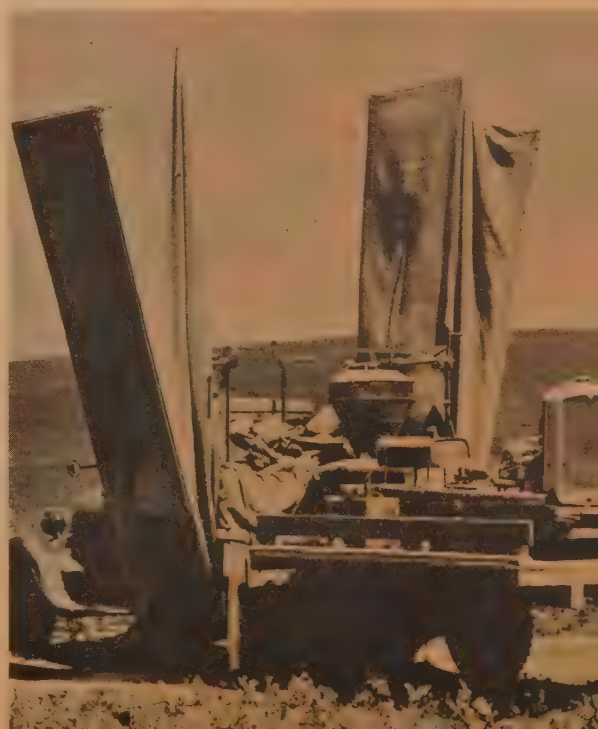
The problem of killing the adults before eggs are deposited is complicated by the fact that the beetles do very little feeding in the adult stage and hence cannot be controlled by ordinary poison insecticides. It so happens, however, that the weevils have little pads of fine hairs on each leg which enable them to cling to smooth surfaces. As these pads become clogged with the rotenone dust, the insects draw them through their mouth parts, prob-

ably to clean them, and thus obtain enough of the poison to cause death.

After it was demonstrated that properly timed dusting would give almost complete control in western Oregon, it was found that the use of border trap crops of earlier blooming peas in the pea growing areas of eastern Oregon were providing entirely ineffective to control the pea weevil in the season of 1937. Entomologists of the Experiment Station immediately transferred their operations to that territory and in cooperation with the federal entomologists began applying the rotenone dust to large plantings there. The problem of applying dust on extremely large acreages despite windy weather conditions was solved through the aid of agricultural engineering specialists. They helped construct large hooded dusters as an adaptation of an idea tried out on a limited scale by a western Oregon farmer. Quick work in developing these large type machines, usually mounted on trucks, made possible the nearly complete control of the infestation in 1937 and again in 1938, so that losses from weevil were far below those of previous years when the infestation was relatively light. Since 1937 the dusting apparatus has been improved and more has been learned of the necessity for accurate timing of the dust applications, and the effect of weather on control.

Pea Aphis Partially Controlled. In attempting control of pea aphis two objectives were sought.

Folding wings facilitate moving from field to field.





Pea aphid control on trellis peas has been accomplished.

One was a method of control for aphid on the tall trellis peas of the coast regions and the other was a method of control which could be applied to large acreages of broadcast cannery peas.

The first objective has been accomplished with the development of a spray which uses rotenone as the active ingredient. This spray consists of rotenone, one part to 15,000; a wetting agent one part to 660; fish oil soap, one part to 440. Two applications of this spray gave better than 99 per cent kill the first year of the trials and 98 per cent the second year. It was applied economically by a spray machine built by the Experiment Station especially for use on the tall trellis peas. Most of the experiments on these were carried out on the Astor Experiment Station in cooperation with Clatsop County growers.

The use of machinery in treating large acreages of cannery peas with liquid spray would be heavy, exceedingly slow and expensive either to own or operate, hence an effort was made to develop an effective dust. Tests were made on 160 plots in 1937 and 188 plots in 1938, requiring the examination of 88,698 pea plants and the counting of 1,034,507 aphids. It was found that the combination of rotenone at the strength of about three-fourths of one per cent plus three per cent wetting agent in a talc carrier, applied at the rate of 50 to 60 pounds per acre, gave the most effective control. With this method, from 70 to 85 per cent control

was obtained in commercial plantings in western Oregon although only about 40 per cent control was obtained in the Umatilla County region. Thus it appears that the rotenone and spreader combination is not the final answer to the pea aphid control problem. It was found, however, that the use in limited trials of certain vegetable oils with rotenone in combination with a spreader in dust form increased the control by about 22 to 29 per cent over the spreader-rotenone combination.

Conclusions

The research carried out under this project has made possible practical and economical control of the pea weevil and thus saved the pea growing industry in the northwest. The research work having been carried through only a few seasons, however, leaves many technical angles still to be determined in order to insure accurate timing of applications under varying seasonal conditions. It is also important that the control measures on large acreages be directed by trained entomologists, insuring accurate observations and timing of applications. The growers and processors have cooperated in maintaining such trained supervision of control campaigns. Practical methods have also been worked out for the protection of home gardens against weevil infestation. Station circular 126 has been issued which gives specific directions for pea weevil control under Oregon conditions.

There is still much to be learned about the control of the pea weevil in seed peas although studies carried out in 1938 resulted in a material reduction in weevil infestation where dust applications were properly timed. Present dusting costs that are practical with canning peas are rather high for seed peas unless timing can be made accurate enough to permit control with one application.

The fundamental solution of aphid control on trellis peas has been worked out and the control of aphid on broadcast peas has been partially accomplished. To the extent that pea aphid are controlled pea mosaic disease is also controlled as shown in the report on pea diseases. The extensive tests with insecticide dusts will need to be continued if more adequate control is to be developed. Tests for control of pea aphid on Austrian winter field peas and vetch have not been conclusive as yet. Further life history and ecology studies of the pea aphid are needed in relation to winter host plants, especially in eastern Oregon.

Pea aphid at work on the tender tip of growing vine.



Pea Diseases

Disease Problems

The three chief diseases threatening the pea industry of Oregon are downy mildew, powdery mildew and mosaic. Where fog and rains favor growing of peas for fresh use and processing purposes they also favor the spread of these diseases. Pea wilt is a lesser but nevertheless dangerous disease.

When downy mildew is bad it may affect all pods on a plant and reduce the pea formation in pods as much as 70 per cent. Fortunately serious outbreaks of this disease have occurred only about once in five years in the past. The pea mosaic common in Oregon is not the kind most prevalent in other areas, hence resistant varieties developed elsewhere have little or no value here.

Results Obtained

A close study of disease conditions in the Eastern Oregon pea growing regions was made and has been reported on in Circular of Information No. 178 which has been published for general distribution. Eastern Oregon pea plantings are remarkably free from disease for several reasons. The peas are grown in a wheat area free from surrounding sources of infection. Growers have constantly used good seed grown by seedsmen in other areas who have kept the stock free from the serious wilt and blight diseases. They have also practiced immediate turning under of vines after harvest which eliminates powdery mildew to a great extent and discourages the development of mosaic. After determining these and related facts it was possible to issue recommendations for continuing the favorable conditions. Later observations this past season emphasized the fact that peas for seed cannot with safety be grown in the same areas as canning peas, and that rotation of fields planted to peas is of utmost importance.

Complete control of mosaic in peas, especially under coast conditions, is practically impossible at present. The disease is not seed borne, however, and as it is spread almost entirely by aphids, the control of these insects constitutes practical control of mosaic. The incubation period—the time between the puncturing of the leaf by aphids and the appearance of the disease has been determined as from 7 to 10 days.



Above—Pea mosaic, on pods and leaves, is largely eliminated by controlling pea aphids.

Below—Downy mildew, most serious disease in Oregon, has not yielded to control.

Much information on the life history of downy mildew has been obtained and extensive spray tests have been made in cooperation with federal research men. As infection takes place while the pods are just emerging from the flower it is almost impossible to apply a spray or dust in time to prevent infection. Apparently the only hope for controlling this disease at present is in development of resistant varieties.

Conclusions

Eastern Oregon pea growing regions are remarkably free from diseases and may be kept that way if care is taken in the selection of seed and in following approved cultural practices. Control of pea mosaic is synonymous with control of pea aphids, hence is dependent on success with the latter. Breeding work for the development of varieties resistant to downy mildew is necessary if control of this serious disease is to be attained. This will, at best, require considerable time.

Pea wilt is controlled effectively by crop rotation in Eastern Oregon.



Dairy Cattle Nutrition Subject of Wide Study

The Problem

Man has made of the dairy cow a machine to manufacture the largest possible amount of milk out of a given amount of feed. Careful selection, breeding and feeding have produced an efficient machine compared with primitive ancestors, but there has been a decline of possibly 50 per cent in the productive life of the average cow today compared with those same ancestors. Undoubtedly much of this decline has been caused by reproductive disorders believed traceable to artificial conditions and intensive breeding and feeding.

Surveys of this condition in Oregon indicate that 15 per cent of the dairy animals, or about 45,000 cows and heifers of breeding age, give difficulty in getting with calf. About 15,000 of these animals are slaughtered annually as non-breeders, bringing the owner about \$35 per animal compared with a replacement cost of about \$75—making an estimated annual loss to dairyman of \$600,000. A further annual loss of about \$500,000 results from temporary sterility or delayed breeding among the remaining 30,000 females showing poor reproductive performance.

Results Obtained

Any study which deals with the many factors involved in the reproductive process in a species such as cattle is complicated, expensive and slow in yielding results. Consequently in studying the problem an attempt has been made to segregate the various factors through controlled conditions and to eliminate those showing no promise as soon as possible.

Growth of suckling rats reveals protein deficiencies in rations used to produce milk.



Sixteen young bulls being raised for use in sterility research.

Vitamin A Studies. Vitamin A deficiency is frequently blamed for breeding difficulties, particularly in regions where weather conditions or methods of harvesting give hay of poor quality. To test this theory 30 pure bred heifers ranging in age from 6 to 20 months were divided into two equal groups, one of which was fed on poor, weathered hay and low vitamin A concentrates, while the other group was fed in addition salmon oil as a vitamin A supplement. Twenty six of the heifers calved normally, three were sold as pregnant heifers, and one aborted. Nothing in this six-months feeding test would indicate any direct relationship between low vitamin A and reproductive trouble with heifers.

Two smaller groups of five heifers each have been given this feeding test for 12 months, with one failing to come in heat. These heifers will be continued on their experimental rations through their first pregnancy and, if funds permit, through the first lactation and second gestation periods.

Vitamin E Studies. Extensive experiments have been made to test the value of giving cows injections of the anti-sterility vitamin E which is being extensively advertised as somewhat of a cure-all for difficult breeding. Although earlier trials here indicated these might have some value, further and more extensive tests, using herds at the state hospitals in Salem and Pendleton, have given results too indefinite for conclusions to be drawn.

Alfalfa Hay Studies. Oregon alfalfa hay is known to be comparatively low in phosphorus which is necessary for normal breeding functions. Alfalfa hay also varies in its quantity and quality of protein, which may have a bearing on reproductive efficiency. Reproductive performance of 12 cows receiving alfalfa hay alone for the past two years has been sub-normal as evidenced by delay in coming in heat after calving, irregular periods between oestrus, or delay in conception.

Inheritance studies. A study of records of dairy cattle in the college herds from 1914 to date reveals significant differences in reproductive efficiency between breeds and between families within breeds.

Milk Production. Feeding tests with an exclusive alfalfa ration show that good dairy cows will produce 50 to 75 per cent as much as when fed balanced rations. The sharp decline in production with alfalfa hay alone appears to be caused partly by deficiency in protein quality and not entirely from a lack of total digestible nutrients. The accompanying chart gives a graphic picture of a record typical of 12 cows tested.

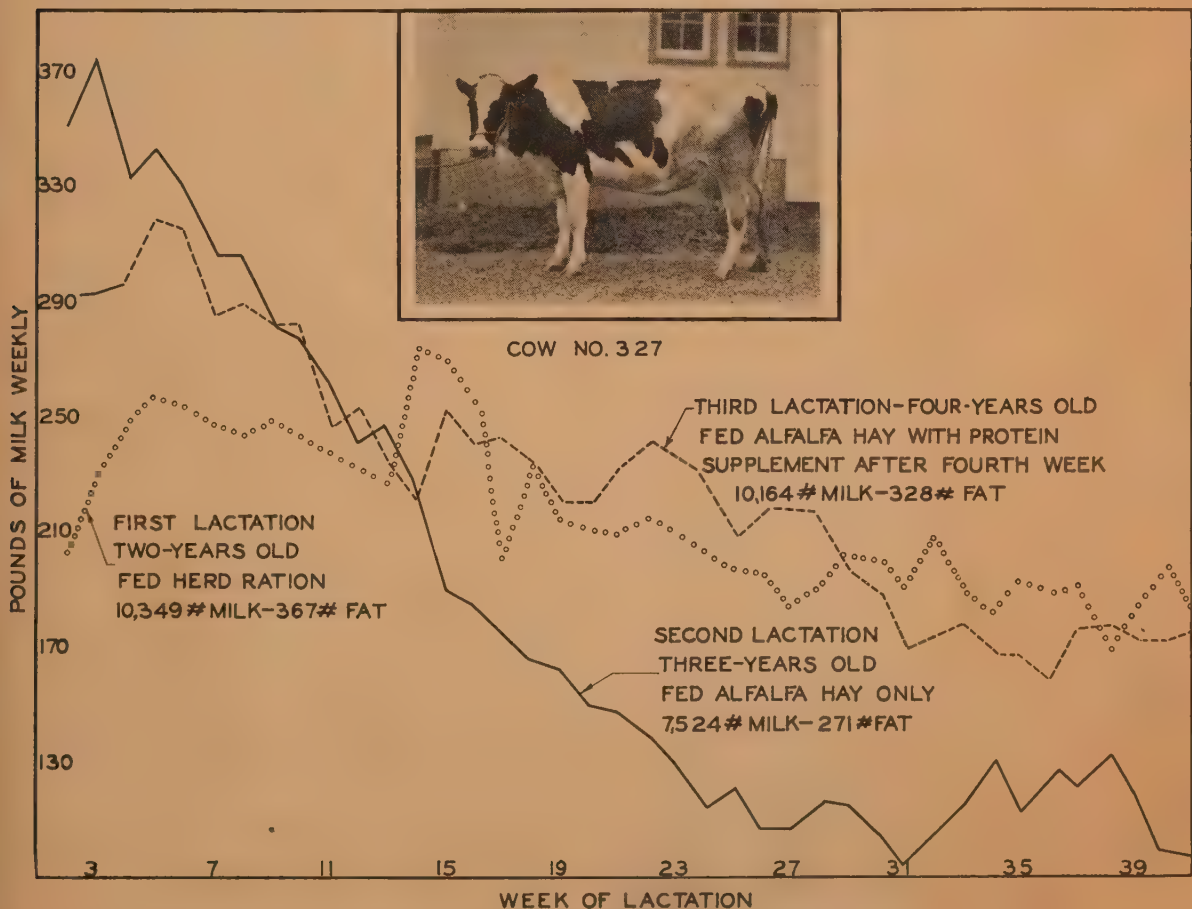
Another factor that may have a vital bearing on the selection of protein supplements for alfalfa is the discovery made by feeding rats protein exclusively from alfalfa. The addition of minute

amounts of cystine, a sulfur containing amino acid, resulted in increasing the milk flow of the mother rats by more than 65 per cent as measured by growth of suckling young. Tests are being made to see if similar response can be obtained from cows.

Conclusions

The studies carried on under this project in the past two years have served to enlarge upon and hasten related investigations so that several factors formerly believed responsible for poor reproductive performances have been largely eliminated. Other valuable new information relating both to bulls and cows has been developed which sheds additional light on the subject of low breeding efficiency, although much work remains before a solution can be expected.

Typical effect on milk production when cows are fed alfalfa hay without protein supplement.



Many Control Methods For Nematodes Tried

The Problem

The root knot nematode has become a serious problem in Klamath, Deschutes and Josephine counties where several hundred farms have suffered losses. The pest is responsible particularly for reduction in yield and quality of potatoes and clover seed. In Josephine county these pests have reduced yields of Ladino clover seed in some instances from normal 250 pounds per acre to 30 to 50 pounds.

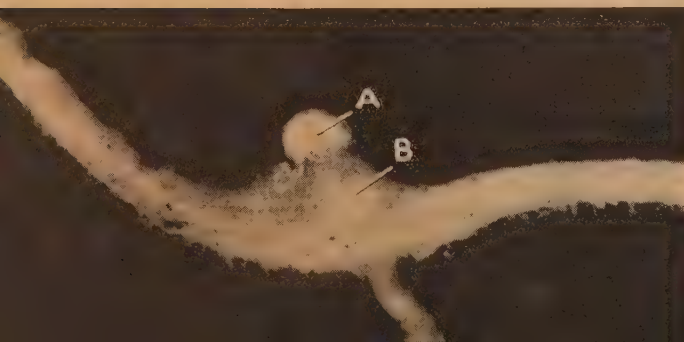
The nematode is neither an insect, such as the symphyliid, nor a disease organism. It is a small worm belonging to the same general class of animal life as the liver fluke. To live and multiply it must find its way into root tissues of a plant. Records indicate that there is a comparatively rapid and steady increase in the spread of this pest to new areas. It not only attacks most of the economic plants but also most of the common weeds. The fact that it has a large number of host plants makes it difficult to control by ordinary crop rotation.

Results Obtained

Experimental trials under controlled conditions were set up in Klamath, Deschutes, and Josephine counties on land that was known to be nematode infested. Each of these tracts was subdivided into areas for fallow, crop rotation and chemical tests.

Chemical Tests. In the experiments to determine the effect of chemicals on the control of nematodes the following chemicals were tried: Calcium cyanimid, sodium borate, sodium chlorate, carbon bisulphide, carbon bisulphite solution

Typical root knot caused by nematode (X 35). Female nema imbedded in tissue shown at B; protruding eggs mass at A.



Hybrid No. 63, a new late heading winter wheat which shows good possibilities for use in crop rotations for nematode control.

from paper mills, and flax retting solution. Cost of these chemical treatments varied from \$4 per acre for sodium borate to \$300 per acre for carbon bisulfide. Chemicals capable of giving control of the nematodes were without exception prohibitive in cost of materials and labor. This phase of the investigation to date gives no promise of a practical solution.

Greenhouse tests were made to assist in determining the effect of chemicals as well as various cultural practices on nematode control. These consisted of growing susceptible plants in the greenhouse in soil taken from fallow, crop rotation and chemical trial plots collected in infested areas. Extent of control can be measured with practical accuracy by counting the number of knots on 100 centimeters of root. These tests confirmed field observations—namely, that cultural and cropping practices offer most promise of control under present conditions. Clean summer fallow gives some promise, but this leaves the land exposed to wind erosion and yields no return to the grower during the fallow period. Chemical control at present is practical only in an attempt at complete eradication of a very limited infestation.

A, partially hatched eggs; and B, larva of nematode (X 400).



Crop Rotation. With crop rotation showing most immediate promise of beneficial control, considerable testing of crop varieties and crop combinations has been carried out in order to find the most profitable system of cropping under various conditions. Among somewhat nematode-resistant crops tried out are winter wheat in Deschutes county, spring barley and corn in Josephine county, various winter and spring grains. Other crops tested included new varieties of flax, alfalfa and strawberry clover in Klamath county.

Rotations with corn as cultivated crop used in Josephine county.



Winter wheat in Klamath county has been hazardous to use because of late spring frosts. A new variety, Hybrid No. 63, developed at Washington State college and grown at the Burns branch station, has proved to have a late heading habit enabling it to miss the usual late frosts. In tests so far it has yielded up to 50 bushels an acre, exceeding Marquis, the present favorite Klamath variety, by 20 bushels on adjoining plots.

Strawberry clover has proved to be an excellent crop for the more alkaline lands, while tests with seed flax have given yields such as to make it a strong possibility for use in future rotations. Alfalfa will apparently always be an important crop in these areas, so tests were made with 16 varieties to get more information on comparative yields, hardiness and resistance to diseases and pests.

In Josephine county where the nematodes have become a serious menace to the ladino clover seed industry, use of corn as an alternate cultivated crop greatly reduced the nematode population.

Weeds constitute a principle means of harbor-

ing and spreading nematodes. Weeds in grain crops do so much damage in this way that sprays have been tried out as a means of eradication. This method shows promise but will need further testing. Thickly planted grain tends to smother the weeds and aid in control. Weed infested ditch banks, which are a constant source of reinfestation of fields, could be better controlled by seeding to nematode-resistant soil binding grasses.

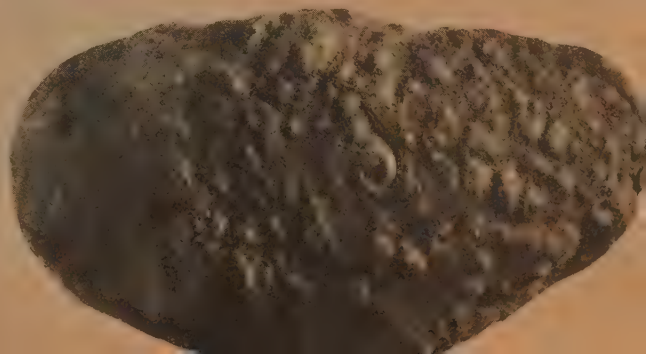
Irrigation practices. Field observations indicate that where irrigation of potatoes has been constant and frequent the soil temperature is kept low enough to discourage nematode activity so that much less infestation occurs. Where temperatures were kept between 59 and 63 degrees F. the infestation was materially less than where temperatures were 70 to 75 degrees F. at a depth of six inches. This method of irrigation is considered good farm practice from other standpoints. More controlled tests of this practice are planned.

Conclusions

Nematode damage is so serious in badly infested areas that control measures are considered imperative by growers concerned. The experiments in past years and those undertaken in this investigation have not yielded positive control but they have resulted in some methods that give limited control, others that show promise, and have served to eliminate others as being impractical. Crop rotation, use or development of resistant crops and varieties, and possibly irrigation practices with potatoes are the most promising developments to date.

Because of the many variable factors involved the program of research now started will require a longer period before definite conclusions can be drawn. Valuable and essential foundation work for such continued investigations has been accomplished.

Injury to potato tuber caused by nematodes imbedded under skin.



Progress Reported with Crumbly Butter Study

The Problem

The occurrence of crumbliness and stickiness in butter in certain seasons of the year in regions where alfalfa hay forms the major winter feed for dairy cows has long been recognized. In an Oregon Experiment Station bulletin issued in 1929 attention was called to this situation and the statement made that the trouble usually occurs when the cattle do not have access to some kind of succulent feed. Since that time the annual production of butter in eastern and southern Oregon, where alfalfa is the predominating dairy feed, has increased until approximately 40 per cent of the state's output comes from those regions. Surveys have shown that the average yearly consumption of hay per cow is 7,015 pounds in the irrigated section, 4,947 pounds in the Willamette Valley, and 3,531 pounds in the coast counties.

Crumbliness and stickiness in otherwise high quality butter has the effect of making the butter difficult to spread, causing consumers to discriminate against it. The loss sustained by the Oregon dairymen on account of crumbliness and stickiness in butter is estimated by dairy and creamery organizations to amount to about one cent per pound of the butter affected, or about \$40,000 per year. The need is to eliminate this loss without materially changing the feeding practices in order to avoid increased cost of production in the alfalfa regions. For this reason the investigation has been concerned primarily with finding the fundamental causes of the undesirable condition from a chemical and physical standpoint and to devise manufacturing methods that will overcome or minimize the effects. The third objective was to study the economic as well as the physical effect of adding certain succulent feeds to the cows' rations in the sections where large quantities of hay are fed.

Crumbly butter (left) is hard to spread. Consumers prefer smooth texture like that at right.



Cream from alfalfa feeding regions was shipped to Corvallis for use in research work.

Results Obtained

The studies have been carried on in the College creamery at Corvallis by means of obtaining cream at regular intervals from alfalfa feeding regions in eastern and southern Oregon. Such cream was obtained in small lots from the Umatilla Branch Experiment Station herd, and in larger commercial quantities through selected creameries. Results of the first year's experiments were unfortunately limited by the fact that the winter of 1937-38 was so open that cows were on dry feed a much shorter time than usual, hence the period over which the undesirable texture of butter could be studied was greatly restricted. An earlier fall in the season 1938-39 permitted the manufacturing experiments to be resumed by October 10.

Chemical and Physical Studies. Fundamental research into the complex chemical nature of butterfat reveal that it is not a single pure fat but is instead a complex mixture of several fats called glycerides. Each glyceride is a combination of a fatty acid and glycerol. It has been found that a very small change in the fatty acid-glycerol combinations present can completely alter the physical and chemical characteristics of butterfat. These combinations are known to be affected by the stage of lactation, breed, season of the year, and feed. Of these factors feed undoubtedly has the most direct influence on the type of butterfat produced.

The laboratory studies made of the butterfat from alfalfa feeding regions showed that it was exceptionally low in its content of volatile fatty acids (Richert-Meissl value and refractive index), low in its degree of unsaturation of the combined fat (iodine value and refractive index), and high in its



An Eastern Oregon creamery where crumbly butter is a problem.

content of the higher melting point components.

To complete this phase of the study it is proposed to make an investigation of the exact chemical composition of the butterfat contained in crumbly and sticky butter and compare it with the fat contained in perfect texture butter. Such additional determinations may reveal other important facts relative to the cause of the difficulty.

Churning Experiments: In carrying out studies of various churning technics, cream received from the alfalfa feeding regions was carefully mixed and then divided into two equal parts for each churning so one lot could be used as a check against the other with which a different procedure was followed. A total of 40 different commercial sized churnings were made as well as many on smaller lots. These churning experiments showed that it is possible by making certain modifications in the manufacturing technic to make some improvement in the body and texture of the butter.

The factors that have been found important thus far are rate of cooling the cream after pasteurization, temperature at which the cream is held after pasteurization and cooling, temperature of the water used for washing and working the butter, and the working intensity. A holding temperature below 48 degrees F. after pasteurization was found to be detrimental to the final body of the butter, increasing the crumbly characteristic. A holding temperature above 55 degrees F. was also unfavorable, increasing the stickiness. The rate of cooling down to 85 degrees F. apparently had no effect, although the rate of cooling between 85 degrees F. and the final holding temperature was of considerable importance. A slow rate of cooling as in a coil pasteurizing vat resulted in a better body in the butter than fast cooling on a surface cooler. This factor, as well as that of the holding temperature, is of major importance and must be more thoroughly investigated by more churnings.

Using cold wash water (34 degrees F.) and allowing the butter granules to become thoroughly

chilled in the water before working improves the body of the butter. This involves a new principle of working that is unfamiliar to butter makers and must be studied further to obtain conclusive results.

A few churnings made where the rate of working the butter was greatly reduced indicated that some improvement in body and texture occurred from this method which has been recommended by European investigators.

Conclusions

The results of the chemical and physical investigations of the butterfat produced in the alfalfa sections of eastern and southern Oregon have shown that there are marked changes in the fat from season to season. This is unquestionably caused by the change in feed consumed by the cows. The fat was hard during the winter months when considerable quantities of alfalfa hay were fed and was relatively soft during other seasons.

The limited number of experimental churnings of butter made from cream from these sections during the brief first season have shown that it is possible to make certain modifications in the manufacturing technic which gives some improvement in the body and texture of the butter. Whether these changes constitute the major or final answer to the problem of eliminating crumbly and sticky butter remains to be determined by further and more comprehensive tests.

The investigation of the possibility of eliminating the trouble by means of a practical modification of the feeding rations in different regions has progressed to the point where significant results are indicated although they had not been carried far enough at the time of this preliminary report to announce conclusions or make recommendations.

Churning experiments have revealed several methods of improving butter texture.



Practical Control Still Sought for Flea Beetle

The Problem

The eastern potato flea beetle, *Epitric cocumeris* Harr., which has caused losses of more than half of the crop in some fields in the Willamette Valley has potential possibilities of becoming a serious menace to the entire potato industry of Oregon. As a result the 26,000 farmers who produced more than 7,000,000 bushels of potatoes from 46,000 acres in 1937 are concerned in the development of methods for the control of this pest. The beetle, first discovered in Columbia county where it was responsible for a reduction of at least one half the crop, has since been found in Multnomah, Clackamas, Washington, and Hood River counties.

Due to the small size of the beetle and its insidious way of working, it may go unnoticed until severe damage is done. It causes an injury to the tubers known as pits and tunnels, materially reducing the grade. Potato foliage is also damaged by the adult beetles.

Results Obtained

Life History Determined. The detailed life history of this beetle was worked out in a special field laboratory constructed in the potato district

Each box contains eggs of flea beetles used in a study of the life history of this pest.



Steps in the flea beetle's life cycle. A, eggs (X 15); B, larvae (X 8); C, pupae (X 6); D, adult beetles, (X 6).

of Columbia county. In this laboratory thousands of eggs were hatched, incubation was determined and the insect was reared and carried through its entire life cycle. Field studies indicated that the beetles overwinter in the ground in and around the fields where potatoes were grown the previous year. They were found in great numbers at the edge of fields wherever there was dense vegetation. Emergence begins the latter part of April, the peak being reached between the last of May and the middle of June.

Dusting and Spraying Trials. Eight different poison dusts and dust combinations were tested. Of these dusts rotenone .5 of 1 per cent mixed with either calcium arsenate or cryolite 20 per cent using talc or diatomaceous earth as a carrier gave almost 100 per cent kill. Rotenone alone is effective when applied, but deteriorates rapidly when exposed to air and sunlight. By the addition of calcium arsenate or cryolite, however, a quick kill is obtained and the lasting properties of the insecticides are enhanced. Since 9 or 10 applications are required during the growing season at an average cost of \$2 per application, the control is not economically feasible on a commercial scale.

Four liquid insecticides including calcium arsenate, Boredaux mixture, calcium arsenate and Bordeaux combined, and lead arsenate were tested on the 1938 crop in varying amounts at different

times and with several applications. On the basis of one year's trials spraying, although showing some promise of control, does not appear to be as practical as dusting. Spraying requires the use of heavy and expensive equipment which frequently causes damage to the crop.

Chemical Seed Treatment. A number of different chemicals were used to treat seed potatoes before planting time to determine what effect, if any, such treatment might have on reducing the activity of the beetles. In the 1937 tests the potatoes grown from seed treated with rotenone-bearing compounds showed 50 per cent less beetle injury than those untreated or those treated with other chemicals. The results from the 1938 tests in which 20 different chemicals were used in treating 3,500



Typical damage to tubers caused by the larvae, and to the leaves by the beetles.

plots were not available when this preliminary report was written.

Inspection of Commercial Fields. More than 50 commercial plantings were examined at 10-day intervals throughout the 1937 and 1938 growing seasons to determine the number of beetles that would be required to cause economic injury; the relation of time of planting to injury; the relation of soil topography and moisture to damaged tubers, and the species of beetle responsible for the injury in each locality.

It was found by field studies that a high correlation exists between beetle population and tuber injury. In checking this phase of the problem in 1937, 40 fields were examined where 114,000 beetles



These tent-like objects are emergence cages used to check the time of emergence of adults in the spring.

were counted and 3,040 pounds of tubers inspected for degree of injury.

Conclusions

Insecticides which will kill flea beetles have been found but because of the large number of applications required and the heavy cost involved, practical control with these insecticides cannot be considered as feasible at this time.

The information which has been gathered on the habits of the insect, the insecticides and dusts which are toxic to it, and the determination of the factors resulting in economic injury are essential to the further investigations which will be necessary before practical methods of controlling this pest can be expected.

Another scene in the field laboratory used in flea beetle research.



Better Control Methods For Weeds Discovered

The Problem

Perennial weeds have become increasingly serious in Oregon until it is estimated that whitetop, morning glory, Canada thistle, Russian knapweed, and quack grass occupy an area equal to one and one-half per cent of the plowable land of the state. When all other perennial weeds are added such as St. John's wort, fern, death weed, and blackberry, the annual "weed tax" amounts to still greater proportions. Weeds lower land values, reduce yields of economic crops, increase production costs, and lower the quality of many farm products. In some instances they even constitute a menace to people and livestock because of poisonous or mechanically dangerous properties.

Weeds are by no means a new problem but many new and improved methods of combatting them have been developed in the past decade which have not been adequately tested under Oregon conditions. The purpose of this investigation was to test various chemicals, cultural practices, smother crops, and any other methods which would give promise of aiding Oregon growers in combatting the serious perennial weed menace.

Results Obtained

In carrying out the weed control research project, experimental plots were located under typical

Dried mounts of worst Oregon weeds. A, quack grass; B, Russian knapweed; C, perennial sow thistle; D, Canada thistle; E, morning glory; F, white top.



Chemical sprays show some promise for control of annual weeds in winter grain.

conditions in both eastern and western Oregon where infestations of important weeds were abundant. The Agricultural Extension Service has co-operated fully in the program.

Chemical Control. In the course of these experiments a total of 864 trial plots were laid out upon which 32 different chemicals and combinations of chemicals were used. The majority of the materials used proved of little benefit either because of ineffectiveness or excessive cost. It has become increasingly evident that there are a great many factors that limit the use of chemicals as effective herbicides.

The most promising material used thus far is an emulsion of sodium chlorate and oil. Plots on which this material was used in 1937 have shown 100 per cent kill of Canada thistle. It can be applied at a slightly lower cost than chlorate alone. The exact nature of the beneficial action added by the oil has not been fully determined. Much work remains to be done also in determining the minimum amounts and most economical combinations that can be used. Oil, when used alone, has proved ineffective except to prevent seed formation.

Potassium chlorate gives some promise of replacing sodium chlorate because of the slightly less damaging effect upon the soil and lower solubility which is an advantage in western Oregon where loss by leaching is common.

Acid arsenical is a chemical which shows considerable promise when applied with a spreader and sprayed at night. A more humid atmosphere definitely aids the killing. If this proves effective it will mean a distinct saving as it can be made up very cheaply.

Sinox, an organic dye, is the latest development for the control of weeds. Its greatest use appears to be as a selective spray for the control of annual weeds in grain fields, grass seedings, nurseries, and the like. Present costs may tend to limit its use.



At left is check plot showing volunteer vetch growth in fall seeded wheat. At right, vetch is killed out in sprayed plot.

Chemical Tests And Soil Types. Studies have been carried out in the greenhouse to determine the variations that occur when chemicals are added to different soil types and under varying conditions. Twelve different classified soils were used in 1250 individual cans or pots with seven different chemicals (see cover cut). The comparative effect of the different chemicals on the soil samples was measured by growing plants in the individual pots. The tentative results of this study show that growth differences of from 10 to 30 per cent occur on different soil types receiving the same chemical treatment, and that more chemical is needed on heavy texture soils than on light soils to achieve the same results.

Chemical Control of Annual Weeds. Five different chemicals were sprayed on wheat and barley plots which were heavily infested with volunteer vetch, chickweed, wild carrot, French pink, and tarweed following the mild winter of 1937-38. Sinox used at 1.5 per cent solution, 120 gallons per acre, killed 97 per cent of all vetch and 100 per cent of all other weeds with very little apparent injury to the grain. A 5 per cent solution of sulphuric acid gave approximately 70 per cent kill. Sodium thiocyanate gave good weed control but injured the grain as well. Ammonium sulphate and

Smother crops shown at rear, and clean cultivation in foreground have their place in weed control.



powdered cyanimid gave little weed control but did stimulate grain growth. On a farm trial in Columbia county, sinox controlled smartweed in plantings of bent grass and flax. Loss from annual weeds in the state as a whole is tremendous.

Chemicals for Lawn Weed Control. Several chemicals give excellent promise in the control of such weeds as dandelions, buckhorn plantain, chickweed, broadleaf plantain, and moss in lawns. In trials conducted under this project, Sinox completely destroyed moss when sprayed at the rate of one-half pound to 130 square feet. Copper sulphate and copper carbonate were effective on moss when used at one pound to 130 square feet. Powdered cyanimid and ammonium sulphate at two pounds to 130 square feet gave 60 to 75 per cent kill on moss and greatly stimulated grass growth. Zinc sulphate controlled moss but iron sulphate was ineffective.

Two applications of sinox—one pound to 260 square feet—approximately one month apart gave better than 90 per cent control of dandelions and both kinds of plantain. Copper nitrate was also effective on dandelions at the rate of two ounces to 130 square feet. Common kerosene has given exceptionally good results with dandelions on limited trials applied at the rate of three quarts to 130 square feet which showed a 90 per cent kill in a heavily infested lawn.

Poison Oak Control. Tests were made on the eradication of individual poison oak plants by submerging one or more branches of each plant in a chemical solution where it was held for several weeks. These tests were made with six chemicals and 180 different treatments. Complete kills of every plant were made with solutions of sodium arsenite or borax one part to 60 of water. When these treatments were made with solutions of different analin dyes, an examination of the roots showed that the material was taken downward more than 20 feet. This type of treatment would

Dandelions in lawn unsprayed (left) and sprayed with kerosene.





Cultivated crops hold Canada thistles in check. A, corn; B, sunflowers.

be impractical for large areas but it should be an effective method of eradicating individual or scattered clumps. Several branches would need to be submerged for large clumps.

Cultural Weed Treatments. Perhaps the greatest progress has been made with a number of new developments in cultivation for eradicating deep rooted perennials. A total of 54 plots, each 1/20 of an acre in area, are being studied in Canada thistle experiments and 13 one-third-acre plots with morning glory. The effects of the cultivations have been measured accurately by taking 340 individual samples of roots. Although the experiments have not reached the point of definite conclusions, a number of facts have been developed.

Cultivation appears to be by far the most practical and economical method of eradicating deep rooted perennials on large areas. The volume of roots of Canada thistle decreased in one season from a total of 7,334 pounds per acre, green weight, to 302 pounds per acre when plots were cultivated every six to seven days after each emergence. Contrary to earlier beliefs, it appears unnecessary to begin cultivation at first emergence of weeds in the spring. Instead it may be delayed until the plants approach the blooming stage. Also, contrary to earlier beliefs, it is becoming more evident that roots are depleted as rapidly by delaying cultivation for eight to ten days and possibly longer after each emergence. This will decrease the cost of eradication by more than half.

Deep cultivation, 12 to 20 inches in the fall, retarded emergence of morning glory the following spring as much as 31 days compared with three to five inch cultivation. Plowing 12 to 13 inches in the fall, plus smoother crops, decreased root vol-



White top along a state highway where grading operations frequently spread these weeds.

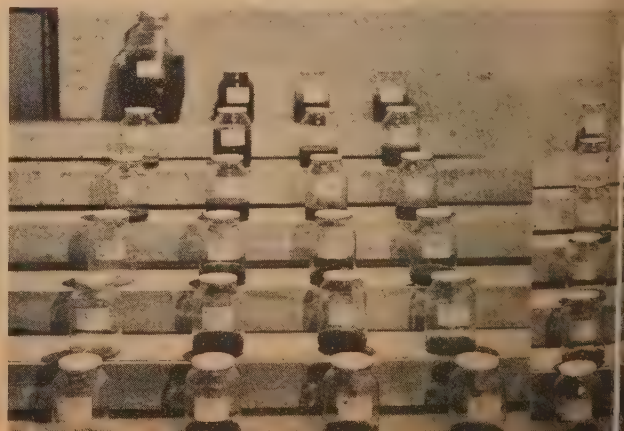
ume more than five times as compared with disking or shallow plowing. Corn and sunflower plots have shown the effectiveness of cultivated crops for Canada thistle control. Three to five cultivations kept the weeds in check.

Conclusions

The experiments carried out under this project have already revealed enough improved methods and materials to save Oregon growers many thousands of dollars through cheaper and more effective control of weeds. The work with chemicals has revealed many fundamental facts although much more experimentation will be necessary to establish most effective and economical dosages of the various chemicals under Oregon's many different soils and climatic conditions.

The control of perennial weeds by cultural practices appears to be by far the most practical for large areas, as newer methods have increased both the economy and effectiveness of such practices. Continuation of the established experimental plots can be expected to reveal many more valuable facts. The work with lawn grass weed control and poison oak eradication will probably find wide application even though on a more limited scale.

Root volume of perennial weeds at different depths from first foot (top row) to sixth foot (bottom row); A quack grass; B, morning glory; C, white top; D, Canada thistle; E, Canada thistles cultivated; F, Canada thistle check plot.



Many Chemicals Tried in Symphylid Control

The Problem

Oregon's commercial truck crop valued at more than \$6,000,000 in 1937 and thousands of home vegetable and flower gardens have suffered severe losses during the past few years from symphylids, a small white centipede-like animal about one-fourth inch long. This pest feeds on germinating seeds, root hairs, and other succulent vegetation. It is known to have 85 different host plants including a large number of vegetable and flower varieties and the seedlings of Russian olive, black locust and Caragana. Two of 54 known species of sym-



Adult symphylid (X5) and damage done by eating roots of onion, lettuce and sprouting pea.

phylids occur in Oregon, sometimes in such numbers as to destroy all sprouting seeds and prevent the growth of plants, even weeds. They have been discovered in widely different soil types in the Willamette, Umpqua and Rogue River valleys and in parts of eastern Oregon.

Results Obtained

In investigating the symphylid problem 32 differently controlled experiments were conducted with chemicals, fertilizers and plants in 18 different fields in Benton, Clackamas, Lane and Yamhill counties, and toxicological measurements were made in the laboratory. The life history, distribution, and host plants were studied, and a bibliography compiled.



Symphylid injury to beans (left) and to Russian olive seedlings in forest nursery.

Chemicals tested. Of the 27 different chemicals applied to infested soil in various ways, all but seven were discarded as ineffective. However, phenothiazine, thallium sulphate, quassia, chloropicrin, and dichlorethyl-ether each gave some promise of control on the basis of one season's tests. Bordeaux and chlorinated naphthalene look encouraging after two years testing. Further experiments will be required to prove the worth of these chemicals.

Fertilizer Experiments. A group of fertilizers including calcium cyanimid, ammonium sulphate, ammonium phosphate, calcium nitrate, and sodium nitrate generally contributed to plant stimulation but had no measurable effect on symphylid population. In those cases where the infestation was moderate, however, the plant stimulation appeared to be sufficient to produce fairly satisfactory crops.

Conclusions

Much valuable new information relating to symphylids has been developed. Many of the experiments which have proved ineffective may now be discarded and replaced with others showing more promise.

Additional tests are needed with those chemicals that look encouraging, and with untested materials. More information is needed on economical methods of application and ultimate effect on soil and plants.

Further information concerning the effect the 15 known parasites and predators of symphylids may have on control is desirable.

Symphylid damage to one end of garden patch of sweet corn.



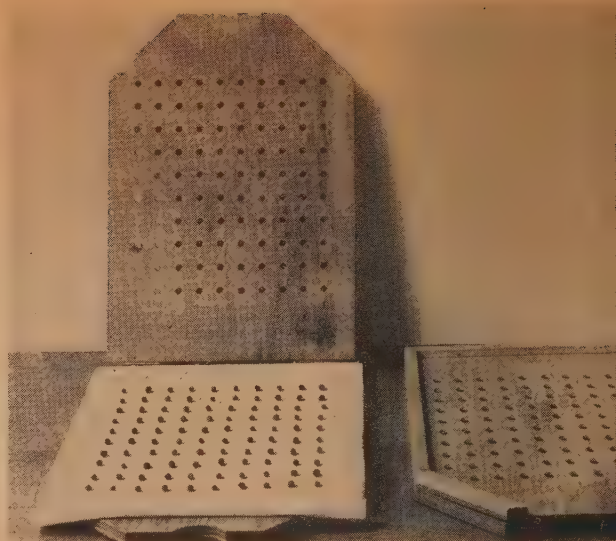
New Facilities Improve Seed Testing Service

With the growth and increasing importance of the Oregon seed industry, the former cooperative arrangement between the Oregon Experiment Station and the United States Department of Agriculture for operating a seed testing laboratory became inadequate to meet the needs of Oregon growers and dealers. As a result of this situation, the 1937 Legislature made an additional appropriation for the support of this work and authorized the laboratory to test commercial, certification, and regulatory seed samples and seed for farmers' own use within certain limitations.

Following the passage of this act a new state-federal cooperative agreement was promulgated and a new supervising analyst was employed. To relieve further the former congestion, a new plan was worked out whereby several of the larger dealers were assisted in establishing small testing laboratories of their own. The Experiment Station aided them in selecting laboratory equipment, trained their analysts and checked with them when necessary. This plan has relieved the Experiment Station laboratory of many excess samples of insufficient importance for an official test. The work within the laboratory itself has been reorganized on a much more satisfactory and efficient basis of performance.

The testing of important official samples and others has been expedited so that the seed industry program of getting seed tested and into channels of commerce in time for seasonal sale has been carried out. Since the reorganization the laboratory has been receiving compliments instead of complaints in regard to the efficiency and dispatch with which samples have been handled.

Trained analysts making purity tests on farm seeds in laboratory



An improved seed counter developed for vetch and pea germination tests.

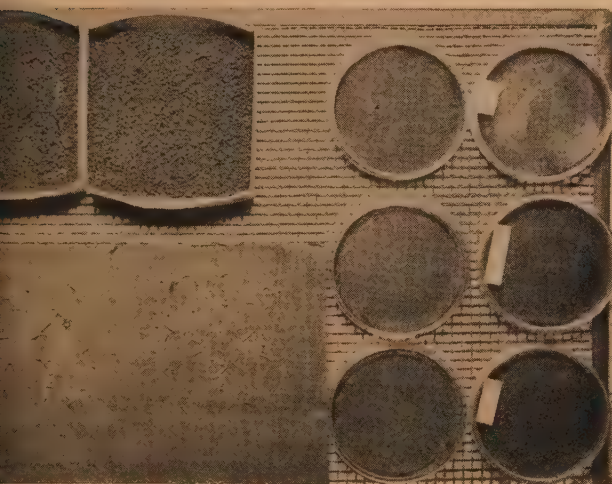
The following table shows the testing work done by the laboratory :

	12 months July 1-June 30 1937-1938	4 months July 1-Oct. 29 1938
Total samples received.....	7,020	3,418
Tests made for :		
Purity	5,715	2,942
Germination	5,288	2,526
Examination	39	12
Identification	239	30
Total tests reported.....	11,281	5,510

New Facilities. New funds provided have made possible the partial fitting of the new germination room, the extension of the vacuum airline for automatic counting equipment, and the building of new seed counters for use in germination tests of peas and vetches. A new electric refrigerator has been installed for chilling certain grass seeds requiring that treatment prior to germination. Three modern electric germination chambers have been installed, as has a new chainomatic balance and a new divider for improving purity testing. A new electric calculator, operated by a clerk, relieves seed analysts of the previous time-consuming hand calculation of percentages. Various minor items of equipment have also been purchased.

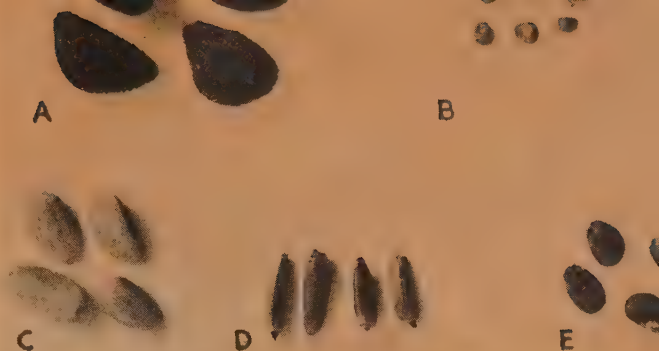
Research Work. Although the new legislation authorized certain research activities the press of current work, as well as the need of using the funds for other purposes, has prevented any extensive experimentation. A number of new seed testing methods have been tried out, however, including germination of onion seed and sugar beet seed—the latter being a new Oregon industry. Identification of some difficult seeds is also being made.

Seed Certification. The seed testing laboratory is an important part of the seed certification work of the College. Field inspections of certain forage grain, turf, and vegetable seeds are made by representatives of the Extension Service where seed certification is sought. Official samples are later



Some experiments have been conducted in farm seed germination methods.

drawn and sent to the seed laboratory for testing. Grade and quality is then determined largely on the basis of this test. Certification work is important in supplying better strains and varieties for Oregon farm use and in providing a standard product which may be marketed advantageously in other states. Certification is applied annually to from $2\frac{1}{4}$ to $2\frac{1}{2}$ million pounds of small seeds and from 5,000 to 10,000 tons of grain, having an annual value up to one million dollars. The following kinds of seed are subject to certification: bent grass seed (4 kinds), English ryegrass, reed canary grass (2 varieties), S 50 timothy, alfalfa (4 varieties), red clover (2 kinds), strawberry clover, Ladino clover, hairy vetch, and small grains.



How some of the worst weed seeds look to the analyst. A, morning glory; B, dodder; C, Russian knapweed; D, Canada thistle; E, white top.

Official Samples. At the suggestion of the Experiment Station, the Department of Agriculture has been authorized to draw, upon request, official samples of lots of seeds that are entering into interstate commerce. These official samples are sent under seal to the laboratory for testing. When the official sampling certificate, accompanied by the official analysis, is attached to the bill of lading, a fine evidence of quality is afforded out-of-state shipments, thus eliminating most controversies between buyer and seller.

Regulatory Samples. The Oregon seed law provides for regulatory work in connection with the sale of seeds for planting purposes in Oregon. Collection of samples and enforcement of the law is in the hands of the State Department of Agriculture. The testing of all regulatory samples was delegated to the Experiment Station with the belief that experience of trained analysts, equipment, herbaria, and other facilities could be utilized rather than incurring the expense of establishing a separate laboratory.

Regulatory samples sent in thus far have been limited in number but it is believed that a larger number will be forthcoming as the department expands its enforcement program. Should the regulatory samples increase in number materially, costs of operating the laboratory would also be increased to the point where either fees for commercial tests would have to be raised or a somewhat larger appropriation be provided.

Part of a battery of seed germinating equipment used in the testing laboratory.



New Findings Revealed For Oregon Poultrymen

The Problem

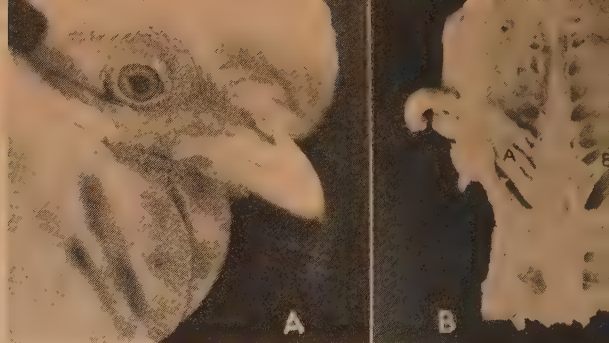
Disease control and efficient management—with marketing—are the principal factors in keeping Oregon's \$8,000,000 poultry industry and \$3,500,000 turkey industry on a profitable basis. Seventy-eight per cent of the farmers in Oregon keep poultry either as a major enterprise or sideline business. Hence approximately 47,000 Oregon farmers are directly aided by information which makes the poultry enterprise a safer business in which to engage. Despite the valuable research works previously carried on in this field, the development of information for the poultry industry has not kept pace with its rapid expansion. The funds provided to support this project were devoted to additional disease control research with both chickens and turkeys and to an investigation of the feasibility of using chick and hen batteries as a method of intensive production in Oregon.

Results Obtained

The extended illness and untimely death on December 29, 1937, of Dr. W. T. Johnson, Poultry Pathologist of the Experiment Station, removed from the entire poultry industry a distinguished scientist and loyal friend. His passing made it impossible to conduct in the time allotted as complete a disease investigational program as planned, hence part of the funds are being returned.

New Facilities. Study of disease conditions in poultry requires the use of specialized equipment for handling birds to prevent the spread of diseases under investigation. Before expanding the disease studies a poultry contagious ward was constructed where birds could be isolated. Construction of a special house and equipment to be used in connection with coccidiosis studies is under way. For the battery management studies, the

The modern, two-story experimental poultry house constructed to study battery management problems.



Neoplastic diseases are a new and serious problem. Left, iritis or gray-eye; right, effect of range or pullet paralysis showing, A, large affected nerve, and B, normal nerve.

Poultry Department remodeled and extended an old service shed to make a modern, well-ventilated and insulated two-story battery building. It provided space for both hen and broiler battery studies and insulated egg storage rooms.

Laryngotracheitis. The construction of a special contagious ward came just in time to pay for itself many times over in providing facilities for handling a sudden outbreak of laryngotracheitis, a disease of the respiratory tract which has caused more than \$100,000,000 loss to the poultry industry of other states. Five outbreaks occurred in Oregon in the summer of 1938. The first caused the death of close to 2,000 birds out of a flock of 7,000. Prompt work on the part of the Experiment Station and the Division of Animal Industry of the State Department of Agriculture resulted in confining the outbreak to the five flocks. It is hoped to eradicate this dread disease from the state.

Coccidiosis. More information on the parasitic disease, coccidiosis, has been discovered at the Oregon station than at almost any other place. The Oregon station is probably the only institution in the world where the six known species of coccidia of the chicken are available in pure culture. With all this information, however, the disease still causes a heavy loss to Oregon poultrymen estimated at about \$250,000 annually. New studies contemplated in this, interrupted as previously mentioned, include investigations of the small intestinal species of coccidia which are the hardest to control under present conditions.

Pullorum Disease. This disease is still by all odds the most serious chick malady despite a known program of control, cost of which has prevented its more universal acceptance. A later method of testing known as the whole-blood stained-antigen test is being studied.





A crew of seven men vaccinated 3,000 poults for fowl-pox and tattooed them in 4½ hours.

Neoplastic Diseases. A group of poultry diseases, cancerous in nature, have in late years constituted a serious problem to the poultry industry. Many phases of the diseases such as cause, transmission, and control are as obscure to investigators as the cancer problem of human beings is to the medical profession. Iritis or grey eye is one disease in this group now being studied. Other related maladies will be included if the investigation is continued. Fundamental ground work is necessary before results can be expected.

Turkey Diseases. The rapid progress of the turkey industry in Oregon has created many new disease problems. The meager investigations of turkey diseases thus far have clearly shown that there are many problems, involving turkeys only, that cannot be solved with information gained in the study of chickens. It is conservatively estimated that annual turkey disease losses in Oregon amount to around \$300,000.

In the preliminary investigations carried on to date five outbreaks of swine erysipelas, a previously unrecognized disease in Oregon turkeys, have been identified. Fowlpox in turkeys has yielded to the vaccination method developed in Oregon but the length of immunity is more limited than with chickens. Studies are underway to develop different techniques in vaccination and to determine more accurately the periods of immunity. Infectious sinusitis or swellhead has yielded to treatment by the use of four per cent silver nitrate solution. Recovery occurred with 94 per cent of the birds so treated.

Hen Batteries. The studies with keeping laying hens in battery cages were started in 1935 but results were not comparable to commercial conditions until the new facilities were developed. Production of the hens in the new battery house averaged 214.9 eggs per hen compared with 219.3 eggs

from hens in check pens. The difference is not considered of commercial significance. Hens kept in batteries for the second consecutive year averaged only 38.3 per cent production or 139.8 eggs per hen. Hens from batteries removed from commercial houses and yards following one year in the cages averaged 51.9 per cent production or 189.4 eggs per hen. This difference of 49.6 eggs in favor of liberty at the end of one year's confinement is commercially important.

Chick and Broiler Batteries. Studies showed that chick batteries have legitimate use for starting chicks, holding chicks for customers, or in meeting other emergencies, but that it is unwise to extend chick confinement beyond a 10 to 14 day period. The tests with broiler production in batteries revealed that the quality of meat from floor-raised broilers was superior to that from broilers raised in batteries. It cost more per pound to raise broilers under floor conditions than in batteries but neither lot returned a profit under the conditions obtaining. Indications are that the use of a fattening ration after birds attain a weight of 1½ pounds is a common industry error. The work is being continued with the use of a special broiler producing ration. Fall hatched chicks for winter broilers are also being tried.

Conclusions

The disease work, while far less comprehensive than originally planned, has brought significant results in the meeting of the laryngotracheitis emergency and in laying the ground work for turkey disease control studies. Important investigations have also been started with coccidiosis, pul-lorum disease and the neoplastic diseases.

In the management studies definite progress has been made in obtaining basic information which will be invaluable in stabilizing and expanding the poultry industry.

A case of sinusitis or swell-head in a turkey being given silver nitrate treatment which was effective in 94 per cent of the cases.



Better Prune Products, Pest Protection, Found

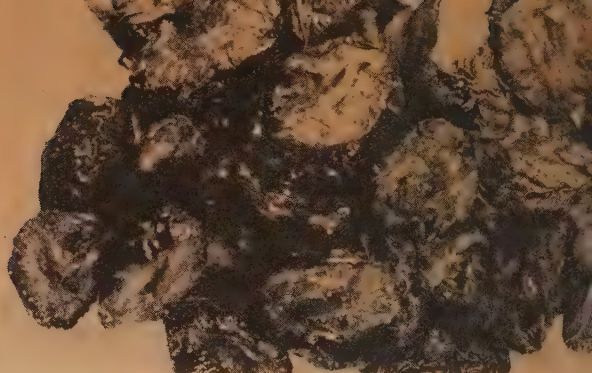
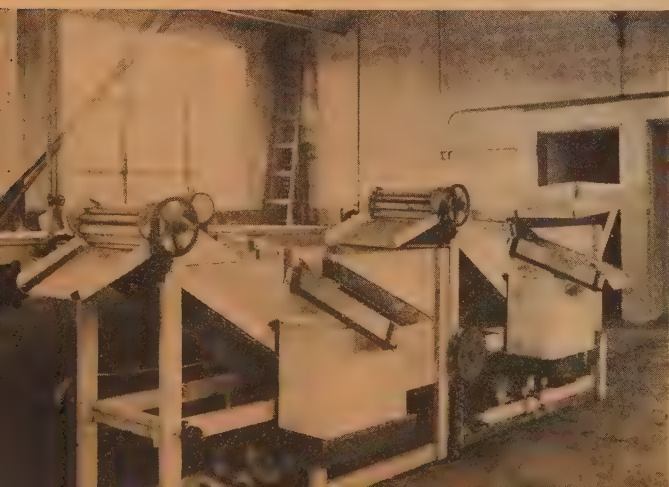
The Problem

New Markets. Although the soil and climatic conditions of Oregon are especially well adapted to the production of quality prunes, acreage has declined during the past few years largely because production has exceeded market requirements. A change in consumer habits, a reduction of exports and other factors appear to be responsible for a reduction in total consumption of prunes in the ordinary dried and packed form. Prices have been so low that many growers have pulled their trees and others contemplate changing to other crops. Hope of retaining or enlarging the present production is dependent to a considerable extent on developing new and superior prune products which may be offered to consumers at reasonable prices.

Insect Pests. Prune thrips have caused serious losses to the prune industry for a number of years by blighting the fruit buds thus reducing the yield and lowering the grade and quality of fruit. Adult thrips destroy fruit buds by sucking the juices from them. They also feed on pistils and stamens causing premature dropping of the fruit. The thrips larvae feed on the prune fruit causing a russet condition. In some orchards 95 per cent of the prunes have been discarded or reduced in grade on account of russet.

Prune Grades. For many years the grading of prunes has been on the basis of size, or the number of prunes required to weigh one pound, necessitat-

A prune grading machine, developed by the Experiment Station several years ago, which separates according to maturity.



Dried halved prunes are more economical to process and ship, and make a more desirable product.

ing a rather large number of classifications without indicating quality. It is believed that a basis which would designate quality and provide for size grades of large, medium and small would be better understood by farmers, housewives and dealers and would stimulate sales.

Results Obtained

The development of five new prune products and the improvement of another has resulted from the investigations conducted during the past two years. These are discussed individually in the following paragraphs.

Canning Dried Prunes. A complete and practical process for canning dried prunes was worked out in the laboratory and made available to the canning industry. The different steps in the canning process include sorting, softening by either the steam blanch, the hot water blanch, or soaking; filling cans, addition of syrup, sealing, and pasteurizing. After cooking the cans are cooled and stored for at least one month before marketing. This process gives a product having excellent quality in convenient containers. Former difficulties with corrosion of cans has been eliminated.

Prune Juices. A quality juice containing mainly sugars, mineral flavors, and solids may now be manufactured from dried prunes. This may be made as a by-product in canning dried prunes or it may be made from small prunes or those culled out because of physical defects. Growers have long sought some method of utilizing small prunes to remove them from market competition with large sizes.

The process for making this juice is simple and inexpensive, consisting of soaking the prunes in $1\frac{1}{2}$ times their weight of water until the soluble solids reach 18 per cent. The juice is then clarified by filtration, is strained and vacuum sealed either in

cans or bottles, and then pasteurized. Samples of this juice were distributed to 15 points over the United States where it met with favorable reaction by the commercial canning industry. A method was also developed for improving the consistency of fresh prune juice.

Prune Pulp. A practical process for making prune pulp from both fresh and dried prunes has been worked out. This pulp has many possibilities in the baking field and is suitable for use in ice creams or other foods. Dried prune pulp is made from refreshed prunes. In making fresh pulp the prunes are washed and sorted, then heated to bring out the bright color and retard oxidation. While still hot the prunes are run through a finisher where the pits, skins and coarse fiber are separated from the pulp mass. Either the dried or fresh pulp may be frozen or canned. Freezing is especially advantageous for the fresh pulp as the natural flavor is retained.

Dried Prune Halves. A superior food product consisting of dried prune halves is made possible by the development at the Experiment Station of a simple machine for halving the prunes. Prunes are now generally dried whole with the pits still in the fruit. The halved prunes are dried under conditions comparable to the drying of whole prunes except lower temperatures are used. The halved prunes dry in one-third the time required for whole prunes and there is practically no caramelization of sugars, so that the natural reddish color is retained. The new method reduces the time of drying, increases the capacity of the drier, saves 10 to 20 per cent of shipping costs, and gives a product more natural in flavor and appearance. Either halved or pitted prunes could be a Northwest monopoly as the French type of prune grown elsewhere has a cling seed that cannot be removed.

Dried Prunes in Small Packages. To meet the demand of housewives for commodities in small convenient packages and to overcome other objec-



A practical machine developed at the Experiment Station to halve the prunes before drying. The cost is more than made up in savings in drying time.



Blossom-end circular stem russet obtained by caging limbs infested with thrips before shucks were shed. Below, normal prunes from thrip-excluded cage.

tions, experiments were conducted to develop such packages. Experiments indicated that dried prunes carrying from 26 to 28 per cent moisture do not need to be subjected to long soaking or stewing. Packing them with this moisture content, however, requires the use of sealed packages which can be sterilized and lined with moisture-proof material. Prunes which were packed in cartons lined with cellophane "300" or with 40 pound parchment retained the original moisture content and showed no mold or insect growth after six months storage.

Dried Prune Standards. The adoption of Oregon standards for dried prunes based on quality rather than size is an achievement in the interest of prune growers, packers and consumers alike. As a result of tests conducted by the Experiment Station and conferences with growers and packers, the State Department of Agriculture adopted official Oregon standards classifying the product into three grades; namely, "Oregon No. 1," "Oregon No. 2," and "Unclassified." Rules provide that the sizes shall be designated on the containers as large, medium, and small. Quality requirements are set for each grade. Adherence to these grades would assure buyers of ability to obtain uniform quality prunes year after year.

Prune Pests. The prune thrips is the most serious pest of the Oregon prune crop. In some years this pest destroys the entire crop in certain



Profitable control of prune thrips was developed. Numbered lots on drier platform from sprayed plots, compared with yields (marked X) from unsprayed plots the same size.

districts. Other pests such as the syneta beetle, the twig borer, the bud moth, mites, aphids, scales, leaf rollers, green fruit worms, tent caterpillars and codling moths do serious damage at times. The investigations during the past two years have been largely centered around the development of control measures for the thrips.

Prune Thrips Controlled. A spray mixture consisting of lime sulphur, three gallons, and nicotine sulphate one pint to 100 gallons of water, is effective in controlling prune thrips. They may also be controlled by a spray of 2 per cent miscible oil emulsion and nicotine sulphate, one pint to 100 gallons of water. Prune trees sprayed experimentally with these mixtures yielded from 62 per cent to 4,000 per cent more fruit than the unsprayed plots.

Successful control depends on proper timing of sprays. The first spray is recommended usually when the peak of emergence is reached. The use of emergence cages is the most reliable for timing sprays.

In these experiments 10 different orchards were utilized in conducting the tests. The orchard owners cooperated by permitting the use of their trees, furnishing spraying and dusting equipment and labor for the operation. A total of eight different sprayers and dusters were used during the two-year period.

A number of different insecticide dusts were tested in a 10-acre prune orchard both in 1937 and 1938. Rotenone proved most effective.

Prune Russet. Prune russet has caused serious damage in some sections. As much as 95 per cent of

the prunes in some orchards have been reduced in grade on account of this injury. To test the belief that part of the russet may be caused by prune thrips, caging experiments were arranged so that thrips were excluded from a series of limbs and enclosed with others. The result of these tests showed that russet did not occur on prunes in those cages from which thrips had been excluded. Those prunes in cages with the thrips displayed a circular stem, blossom end, and slight side russet. It has also been determined that russet is caused from mechanical injury.



Adult thrips (X 100). This insect causes tremendous losses unless controlled by a successful method developed in these studies.

Conclusions

The development of new uses for prunes and the creation of new products and by-products should stimulate consumption and enable prune growers to find a better market for their output. Other experiments concern the use of dried prune pulp for cereals, methods of separating inferior prunes from the good fruit after drying, the extraction of oils from pits, and the utilization of the shell and flesh are underway. The research will need to be continued to complete the projects which have been started.

Experiment Station bulletin No. 353 presenting detailed information on dried Italian prune products was issued in June, 1938.

A successful method of controlling prune thrips has been developed for the first time and is now in commercial use. Further tests on timing are desirable, however, as are additional experiments with possible control with dust instead of liquid sprays. Substantial progress with the control of prune russet has been made but has not been carried to completion.

Prune blossoms "blasted" by thrips (above) and normal bloom.



Specialty Crops Income Shown in State Survey

Agriculture, like all great industries, needs accurate and complete statistical information for the guidance of production and marketing operations. Such data are used by farmers, farm organizations, and by farmers' agents, representatives, and spokesmen in planning agricultural production to meet market demands and in working out such vast projects as the agricultural adjustment, land use, and soil conservation programs. These data are used in connection with various marketing programs involving standardization, warehousing, credit, advertising, and distribution; in transportation matters involving facilities and returns; in tariff and trade agreement problems, and as a basis for agricultural legislation.

Lack of official data concerning the production and marketing of Oregon's specialty products has been a serious handicap and has caused the state to be shown as of much less importance agriculturally than the facts warrant.

To meet the needs for information on specialty crops the 1937 Legislature authorized an extensive survey throughout the state. More than 700 persons—growers, shippers, dealers, manufacturers, and others—were contacted to obtain statistical information available. The work was carried on by the office of the Agricultural Economist of the Federal Cooperative Extension Service.

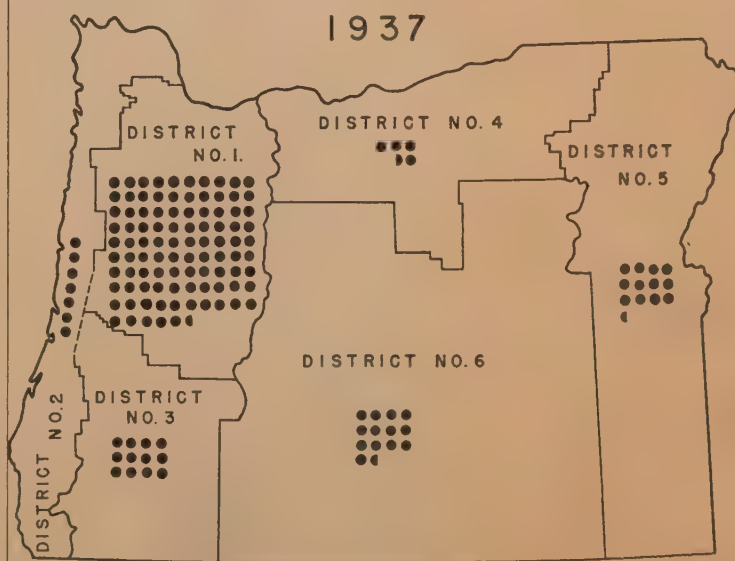
This survey resulted in the listing by counties, estimates of acreage, of price, and of income from certain specialty farm products in Oregon. This information was published in Extension Circular No. 318 presenting the data for 1936. A companion bulletin giving even more complete statistics for 1937 was scheduled for publication in December 1938. The bulletin contains a list of Oregon's important specialty crops not included in the regular crop estimates of the Bureau of Agricultural Economics.

Some of the crops omitted from the government compilation on which statistical information has now been obtained for the first time are vetch and field pea seeds, most of the grass seeds, ladino clover seed, flax seed, fiber flax, peppermint, turkeys, fur bearing animals, honey, flower seeds and bulbs, and many other items. Information is now available on these by counties and by agricultural regions of the state.

The survey shows that these and related specialty crops are now of marked importance in the state's agriculture, having increased greatly in the past ten years. For example, in 1936, 53,000,000 pounds of forage seed harvested from 137,000 acres had a market value of more than \$3,000,000. Cane fruits harvested from 8,370 acres produced an income amounting to approximately \$1,000,000. The only complete county-by-county survey of the cash farm income from the turkey industry ever made in the United States so far as known shows that Oregon produced 1,166,000 turkeys in 1936 which sold for \$2,846,500. Average farm price for that year was 17.2 cents per pound. Total state production was 17,306,000 pounds.

OREGON CASH FARM INCOME FROM CERTAIN SPECIALTY FARM PRODUCTS BY TYPE OF FARMING DISTRICTS

Each dot (•) represents \$100,000
from crop and animal products.



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The Oregon Research Program for the Agricultural Industry

THE fundamental character of Oregon's agricultural industry, with its multiplicity of crops and farming enterprises and its wide diversity of soil, topography and climatic conditions, has throughout the years required for its support a far reaching and comprehensive program of agricultural research.

The special investigations reported on in the preceding pages and which are financed with funds appropriated by the 1937 legislature for each specific project, constitute but a small part of this continuing statewide research program. Funds for the regular investigations of the Agricultural Experiment Station, derived from both federal and state sources, are devoted also to specific and well organized projects planned through a considerable period of years in line with the determined long-time needs of the state.

Such fundamental research is the daily task of the agricultural research staff at the central station at Corvallis and at the 10 branch stations located throughout the state, each devoted to distinctive fields of investigation. The state controlled portions of this work are supplemented by additional fundamental investigations conducted by specialists of the United States Department of Agriculture working cooperatively with the state.

The primary interest of the government is with problems of a regional character of benefit to more than one state. Many federal scientists are now located at the Oregon Station investigating such problems under cooperative agreements. Through this arrangement Oregon receives early benefits of extensive experiments which could not be financed from state funds alone.

Through such a coordinated program of agricultural research hundreds of projects are carried on constantly for the benefit of Oregon's highly specialized agricultural industry. Projects designed to protect crops and livestock from destruction by diseases and pests are being conducted. Experiments in converting waste and off-grade products into materials of economic value, and in processing crops and products to improve quality and meet market demands, are receiving special attention. Tests and breeding work are carried on with fruit, vegetable, nut, forage, seed and field crops to introduce or develop new and superior strains to be grown with less cost and greater profit. Research is carried on with rotations, tillage, pollination, feeding, brooding, nutrition, costs of production, farm home conveniences, soil fertility, irrigation and many other projects—all to the end that production and marketing efficiency may be increased with resultant benefit to Oregon farm life.

The facts and principles that have thus far been discovered and developed by the Experiment Station and applied to Oregon farms by the Federal Cooperative Extension Service are estimated conservatively to be worth ten million dollars annually to the state of Oregon.

COAST

DAIRYING

AVE. GROWING SEASON 282 DAYS

AVE. RAINFALL 77 INCHES

ALTITUDE 0-200 FEET

WILLAMETTE VALLEY

GENERAL FARMING

AVE. GROWING SEASON 182 DAYS

AVE. RAINFALL 45 INCHES

ALTITUDE 100-500 FEET

SOUTHERN OREGON

FRUIT AND GENERAL FARMING

AVE. GROWING SEASON 150-170 DAYS

AVE. RAINFALL 18-24 INCHES

ALTITUDE 1500-2000 FEET

CENTRAL OREGON

RANGE LIVESTOCK DAIRYING SEED AND POTATOES

AVE. GROWING SEASON 63-100 DAYS

AVE. RAINFALL 7-12 INCHES

ALTITUDE 3500-5000 FEET

COLUMBIA BASIN

DRY LAND WHEAT - IRRIGATION FARMING

AVE. GROWING SEASON 150-184 DAYS

AVE. RAINFALL 8.4-14 INCHES

ALTITUDE 400-2000 FEET

BLUE MOUNTAIN

GENERAL FARMING LIVESTOCK

AVE. GROWING

SEASON 118-180 DAYS

AVE. RAINFALL 10-14 INCHES

ALTITUDE 2700-3500 FEET

